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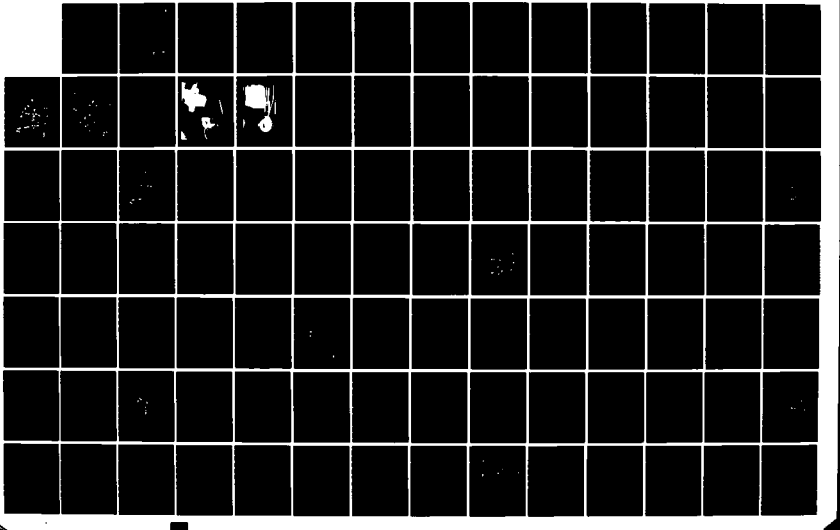

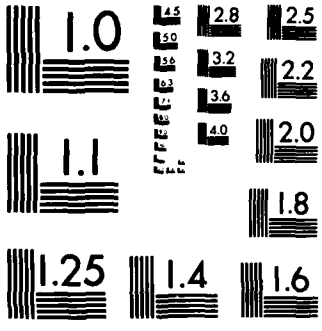

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Technical Report E06549-10
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ELF COMMUNICATIONS SYSTEM ECOLOGICAL MONITORING PROGRAM: MEASUREMENTS OF ELF ELECTROMAGNETIC FIELDS FOR SITE SELECTION AND CHARACTERIZATION - 1983

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January 1985

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A long-term program for studying possible effects from the operation of the Navy's ELF Communications System is being conducted on biota and ecosystems components in northwestern Wisconsin and the Upper Peninsula of Michigan. Sixteen general types of organisms from three major ecosystems in the ELF system area are being examined. Formulation of an ELF Ecological Monitoring Program was completed in early 1982 by the Department of the Navy. Monitoring studies were conducted through a peer-reviewed, competitive bidding process in mid-1982, and studies were initiated in late summer. Major activities of the program during 1983 consisted of characterization of critical aspects of each study, collection of data to validate assumptions made in proposals, and selection of study sites. Measurements of electromagnetic fields at the investigator-selected sites are documented, and the acceptability and status of the sites in light of the electromagnetic exposure criteria are discussed.

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FOREWORD

This report documents measurements of extremely low frequency (ELF) electromagnetic fields made in support of the Navy ELF Communications System Ecological Monitoring Program during 1982 and 1983. This work was funded by the U.S. Naval Electronic Systems Command, Communications Systems Project Office, under Contract Numbers N00039-81-C-0357 and N00039-84-C-0070, to IIT Research Institute (IITRI). IITRI measurement personnel were M. M. Abromavage, J. O. Enk, J. R. Gauger, W. F. Lancaster, G. L. Nicholas, D. Osowski, S. Tumarkin, and Dr. J. E. Zapotosky.

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1. INTRODUCTION

To assure an understanding of the long-term effects on nearby ecological communities of operating an Extremely Low Frequency (ELF) communications system, the Naval Electronic Systems Command has established an Ecological Monitoring Program to study a variety of sensitive species in the vicinity of its ELF transmitting facilities, both present and planned. This program is being conducted by numerous investigators in Wisconsin and Michigan under subcontracts to IIT Research Institute (IITRI), which provides overall program management as well as electromagnetic measurement and engineering support. The Ecological Monitoring Program was initiated in 1982 and is expected to continue for several years.

The extremely low frequency electromagnetic fields produced by ELF transmitting antennas have intensities in the air and in the earth that approximate those attributable to commercial power systems. Since the purpose of the Ecological Monitoring Program is to detect whether unexpected ecological effects might result from long-term ELF Communications System operations, it is important that fields produced by ELF antennas are distinguishable from the ambient electromagnetic fields at locations selected for studying ecological effects. Criteria for electromagnetic exposure have therefore been established as reasonable goals for site selection so that rational interpretations of the future results of studies can be made. These criteria are in addition to those required to satisfy the biological aspects of the studies.

This report reviews the electromagnetic exposure criteria and measurement protocols, documents the measurements of electromagnetic fields at the investigator-selected study sites during late 1982 and 1983, and discusses the acceptability and status of the sites in light of the EM exposure criteria.

2. ELF ELECTROMAGNETIC SITE SELECTION CRITERIA

2.1 PAIRED-SITE ELECTROMAGNETIC EXPOSURE RATIOS

The electromagnetic fields produced by an ELF communications system can be described briefly as follows:

- a magnetic field, the same in the air and in the earth, which is generated by the current in the antenna element;
- an electric field in the air which is produced as a result of the potential difference between the antenna element and the earth;
- an electric field in the earth which is the sum of those produced by the magnetic field in the earth and by the current flowing in the earth from the buried wire elements of the antenna ground terminals.

The ELF fields in question are centered at a frequency of 76 Hz. Commercial power system transmission and distribution lines generate similar electromagnetic fields at a fundamental frequency of 60 Hz. Hence, both ELF and power line frequency fields must be considered in characterizing the electromagnetic environment at the ecological study sites.

The Ecological Monitoring Program employs paired test and control sites to study the effects of ELF electromagnetic fields on biological and ecological parameters. Such paired sites have essentially matched biotic and abiotic characteristics, but purposely dissimilar ELF exposures. To aid investigators in selecting study sites, criteria were established for minimum values of electromagnetic field ratios between paired sites. These criteria were incorporated into the contractual statements of work for each investigator as follows:

> Control plots shall be selected at locations where electric fields in soil near the surface of the earth produced by the ELF system are on the average at least one order of magnitude and preferably two orders of magnitude less than those at paired test plots. The same relationship shall exist for magnetic field components between test and control plots. Electric and magnetic fields in air and earth produced by other ELF sources (e.g., power lines) shall not differ by more than one order of magnitude between paired test and control plots, and at test plots should be at least one order of magnitude below the fields produced by the ELF system.

In addition, it is desired that the fields produced by the ELF system at the test site be at least one order of magnitude higher than the 60 Hz fields (e.g., power lines) at both the test and control sites.

The above conditions can be also stated mathematically with four statements of inequality:

1) $\frac{T\ (ELF)}{C\ (ELF)} \geq 10$

2) $\frac{T\ (ELF)}{C\ (60)} \geq 10$

3) $\frac{T\ (ELF)}{T\ (60)} \geq 10$

4) $0.1 \leq \frac{T\ (60)}{C\ (60)} \leq 10.$

where:

T (ELF) = Test site EM field level due to ELF system
T (60) = Test site EM field level due to power lines
C (ELF) = Control site EM field level due to ELF system
C (60) = Control site EM field level due to power lines.

These ratio criteria and inequalities, if met, will assure that the ELF system electromagnetic fields at a test site will dominate its ambient and paired-site electromagnetic fields by at least a factor of ten, while also assuring that the paired-site ambient EM fields from power lines will be matched to within a factor of ten or better.

2.2 GEOGRAPHICAL CONSIDERATIONS

The study investigators were given maps of the existing Wisconsin and proposed Michigan ELF antenna rights-of-way prior to the start of the 1983 field season, along with information on the theoretical nature of the ELF electromagnetic fields by and near the antenna systems. This information was in the form of computer-generated electric field contour map overlays and

curves of the electric and magnetic field intensity variation with distance from the antennas. These materials, although based on simple analytical models, were judged sufficient to provide investigators with first order site selection guidance with respect to the electromagnetic requirements of paired sites.

In addition to the antenna topography and analytical calculations, map overlays were provided which indicated the location of power transmission and distribution lines in the areas immediately adjacent to the antenna systems. These data would aid investigators in avoiding sites near such lines where excessive 60 Hz EM fields would likely be encountered.

3. ELECTROMAGNETIC FIELD MEASUREMENTS

3.1 SITE LOCATIONS

Each ecology study investigator was responsible for selecting potential field sites that satisfied the biological requirements of his study. During the 1983 field season, IITRI personnel documented the sites identified by the investigators and selected measurement locations within each site. A summary of the number of sites and corresponding measurement locations appears in Table 1. As indicated in the table, there were a total of 116 measurement locations at 68 test and control sites.

TABLE 1. 1983 MEASUREMENT LOCATIONS SUMMARY

Study	Test & Control Sites	Measurement Locations
Small Mammals and Nesting Birds	10	21
Native Bees	6	6
Soil Arthropods and Earthworms	12	12
Upland Flora	5	12
Aquatic Ecosystems	11	14
Soil Amoebae	5	5
Slime Mold	4	4
Wetlands	15	42
TOTALS	68	116

The ELF electromagnetic fields at each of the sites were measured by IITRI field crews. The need for one or more measurement locations was determined on an individual basis at each site, based on plot size and other factors, in order to provide an accurate evaluation of the ELF electromagnetic environment in that area.

Figures 1 and 2 illustrate the locations of the field sites identified in 1983 relative to transmitter facility antenna elements.

Figure 1 shows the location of field sites for the Michigan ecology studies relative to the planned Republic (Mich.) transmitter facility antenna elements. The six ecology studies for which electromagnetic field measurements were made are identified in the upper left-hand corner of the figure. The black dots represent the locations of field sites at which IITRI field crews were asked to evaluate the ELF electromagnetic fields.

Similarly, Figure 2 shows the location of field sites for the Wisconsin ecology studies relative to the Clam Lake (Wis.) transmitter facility antenna elements. The two ecology studies for which electromagnetic field measurements were made are identified in the upper left-hand corner of the figure. Again, the black dots represent the locations of field sites at which IITRI field crews were asked to evaluate the ELF electromagnetic fields. The field sites indicated in this figure also include those sites identified in the latter part of 1982 for the slime mold study. The slime mold sites, along with their corresponding ELF electromagnetic field measurements, were previously documented in IITRI Technical Report E06516-4.[1]

Individual ecology study field site locations are provided in Appendixes C through H.

3.2 MEASUREMENT PROTOCOL

Electromagnetic field intensity measurements were taken at each measurement location identified. The magnetic flux density and the electric field intensities both in the air and in the earth were measured using directional field probes designed and calibrated by IITRI. Each of these probes, when placed in the existing electric or magnetic field, as appropriate, outputs a voltage proportional to the field intensity. The value

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5. REFERENCES

1. Measured Electromagnetic Fields at ELF Communications Program Ecological Study Plots: Slime Mold Studies in the Chequamegon National Forest, Wisconsin. IIT Research Institute Technical Report E06516-4, February 1983. J. Enk. Available from National Technical Information Service (NTIS), Springfield, Va.

2. An Improved ELF Electric Field Probe. IIT Research Institute Technical Memorandum No. 2, IITRI Project No. E6249, March 1974. V. C. Formanek. Available from NTIS.

3. Compilation of 1982 Annual Reports of the Navy ELF Communications System Ecological Monitoring Program. IIT Research Institute Technical Report E06516-5, May 1983. Available from NTIS.

Additional EM field measurements for site selection and characterization were scheduled for early spring 1984 so as to provide the study investigators with an entire field season for baseline data acquisition. Annual EM field verification measurements will be made at each of the selected test and control sites later in the year. As in 1983, specific EM engineering support will be provided to the ecology studies on an as-needed basis.

both the ELF electromagnetic and the biological components involved. The investigators plan to optimize the data collection points within the test site in order to enhance the field intensity differences between test and control pairs. Further ELF electromagnetic field characterization will be required based on the final boundaries of the selected test site.

4.2.6 Soil Amoebae Studies

A previously identified test site located at antenna ground terminal number 4 will have to be relocated due to changes in the overhead and ground portions of the antenna element there.

4.2.7 Slime Mold Studies

The investigators have requested that an additional test site be located and measured at an overhead portion of the antenna element.

4.2.8 Wetlands Studies

These studies will use an ELF electromagnetic field gradient design rather than the paired-site concept. Five test sites (three overhead antenna and two ground terminal), seven intermediate field intensities, and three control sites have been identified. However, unforeseen logging near one of the previously identified control sites will require the relocation of that site.

4.3 CONCLUSIONS

During 1983, the ELF electromagnetic fields at 68 ecological study sites were characterized with a total of 116 sets of measurements. All potential study sites which were identified by investigators before and during the 1983 field season were visited by IITRI field crews, ELF EM field measurements were made, and the results were documented.

The principal investigators of the eight ecological studies were provided with details of the measurement site locations, summaries of the measured electromagnetic fields, and analyses of the EM exposure acceptability of each of their test/control site pairings. Seven investigators have since requested additional site characterizations for 1984 because of logging near their sites, relocation of antenna or ground elements, unacceptable EM exposure, or other reasons mentioned earlier.

acceptable site pairs had been identified as possible selections for each study, as can be seen in Table 2.

4.2 STATUS OF SITE SELECTIONS

Based on the responses received from each of the ecology study investigators by the end of 1983, only the soil arthropods and earthworms study had completed the site selection process. The following paragraphs summarize the status of the site selection process for each of the ecology studies as of the end of 1983.

4.2.1 Small Mammals and Nesting Birds Studies

Based on unforeseen logging activity and proposed changes in the final position of the overhead antenna element and the antenna ground terminal number 4, a previously satisfactory test site required relocation. Additional ELF electromagnetic field site characterization may be required due to the use of specially designed field enclosures for the small mammals studies.

4.2.2 Native Bees Studies

The investigator has requested that additional control sites be located and measured. The field intensity levels at a frequency of 60 Hz were felt to be too high for use.

4.2.3 Soil Arthropods and Earthworms Studies

A test/control site pair found to be acceptable for the ELF electromagnetic field exposure component also satisfied the biological components of the studies. No further work is anticipated as part of the site selection process for these studies.

4.2.4 Upland Flora Studies

Based on the positioning of antenna ground terminal number 5, a previously identified test site will have to be relocated. The investigators have also requested that an additional control site be identified and measured.

4.2.5 Aquatic Ecosystems Studies

A test/control site pair found to be conditionally acceptable was selected by the investigators as the field study site pair, based on review of

These categories were defined as follows:

Acceptable. A test/control site pair was placed in this category if it satisfied all four EM exposure inequalities given in Section 2 for each of the EM fields applicable to the study. For example, the small mammal and nesting birds study would be concerned with both the soil and air electric fields as well as the magnetic fields. The soil arthropods and earthworms study, however, would not be concerned with the electric field in air since this field terminates at the earth's surface and would not be expected to impact biota existing in the soil or litter layer.

Conditionally Acceptable. A test/control site pair was placed in this category if it approached, but did not meet, the conditions for acceptability. This category was established after recognizing three things. First, the electromagnetic exposure criteria were not rigidly defined. The assumption that a difference of one order of magnitude or greater would constitute a significant difference between test and control sites has been chosen for these studies, but without knowing what effects will be experienced, if any. It is difficult to define this difference a priori. Second, for the Michigan ecology studies, the 76 Hz field values were estimated for each measurement location. These estimates were based on a set of estimated electrical parameters (i.e., antenna operating conditions, earth conductivity, and the distance between the measurement location and the planned antenna elements). Some variation can reasonably be expected between the estimated field values and those which will actually be produced when the antenna is built. Third, the EM field measurements themselves encompass a certain degree of error, as do any physical measurements.

Unacceptable. A test/control site pair was placed in this category if it neither satisfied the applicable acceptance criteria nor qualified for conditional acceptance.

During the last quarter of 1983, the principal investigator for each study was sent a detailed listing of the calculated EM field intensity ratios used in applying the exposure criteria to his sites. These tables are provided in Appendixes A through H. It was indicated to the investigators at that time that a particular site pair falling in the unacceptable category was unacceptable for further study because of the ELF electromagnetic field exposure alone. The final decision on choice or selection of any of the study site pairs falling in the acceptable or conditionally acceptable categories was left up to the investigator, as the effects of both the electromagnetic exposure and the biological components on the study protocol need be considered here. Based on the number of site pairs planned for each study as of the end of 1983, an adequate number of acceptable and/or conditionally

4. RESULTS AND CONCLUSIONS

4.1 APPLICATION OF EM EXPOSURE CRITERIA

The electromagnetic exposure criteria for site selection discussed in Section 2 were applied to the EM field measurement data for each of the investigators' studies. All possible combinations of test and control site pairs within a study were analyzed for acceptability. The results of this exercise are summarized in Table 2. As shown, each site pair was placed in one of three categories: acceptable, conditionally acceptable, or unacceptable.

TABLE 2. ELF EM FIELD EXPOSURE CRITERIA APPLIED TO TEST/CONTROL SITE PAIRS

Study	Planned Test/Control Pairs	Number of Possible Test/Control Pairs	Acceptable	Conditionally Acceptable	Unacceptable
Small Mammals and Nesting Birds	2	7	5	1	1
Native Bees	4	8	1	3	4
Soil Arthropods and Earthworms	1	27	19	2	6
Upland Flora	2	6	3	1	2
Aquatic Ecosystems	1	6	0	2	4
Soil Amoebae	2	6	2	0	4
Slime Mold	2	4	1	2	1
Wetlands	15	15	14	1	0

3. The component field levels at 76 Hz were linearly extrapolated to correspond to a full antenna operating current of 300 amperes (each field is directly proportional to the antenna current).

4. The field magnitudes for each antenna condition were calculated as the root-sum-square (RSS) of their orthogonal components.

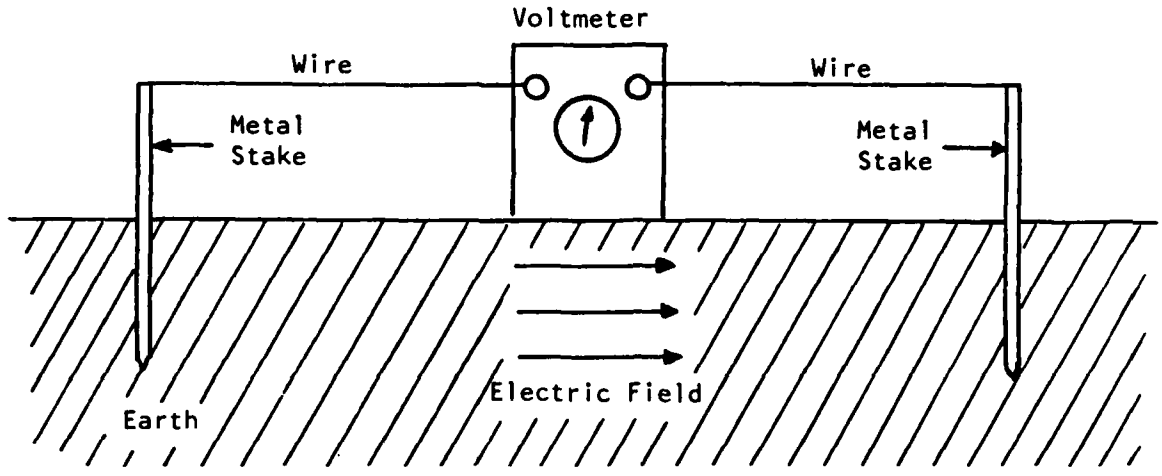
5. The "worst case" 76 Hz field magnitudes were computed as the algebraic sum of the magnitudes due to each antenna.

The measurement protocol used for the Michigan ecology study sites did not include the measurement of 76 Hz fields. Attempts were made at several locations in Michigan to measure the ELF fields generated by the Wisconsin system; however, no fields were present within the instrumentation's lowest limits of detection.

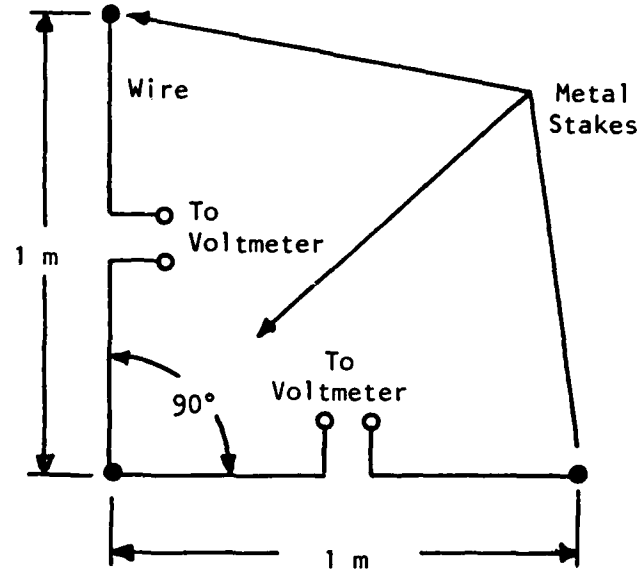
Electromagnetic field intensity data at a frequency of 60 Hz were recorded for each measurement location selected at the Michigan ecology study sites in a manner similar to that used for the Wisconsin study sites.

In order to evaluate a particular test and control site pair for the Michigan studies, estimates of the 76 Hz electromagnetic field intensities were analytically calculated for each measurement location. These estimates were based on calculations utilizing the proposed operating conditions of the Republic transmitter facility antenna elements and the distance from the proposed antenna elements to each measurement location.

Both summarized and detailed listings of the measured 60 Hz and 76 Hz field data for the Wisconsin studies and the measured 60 Hz and estimated 76 Hz field data for the Michigan studies can be found in Appendixes A through H.



a. Measuring a horizontal electric field in the earth



b. Geometry for perpendicular probe wires

Figure 5. Electric field in the earth; measurement and geometry.

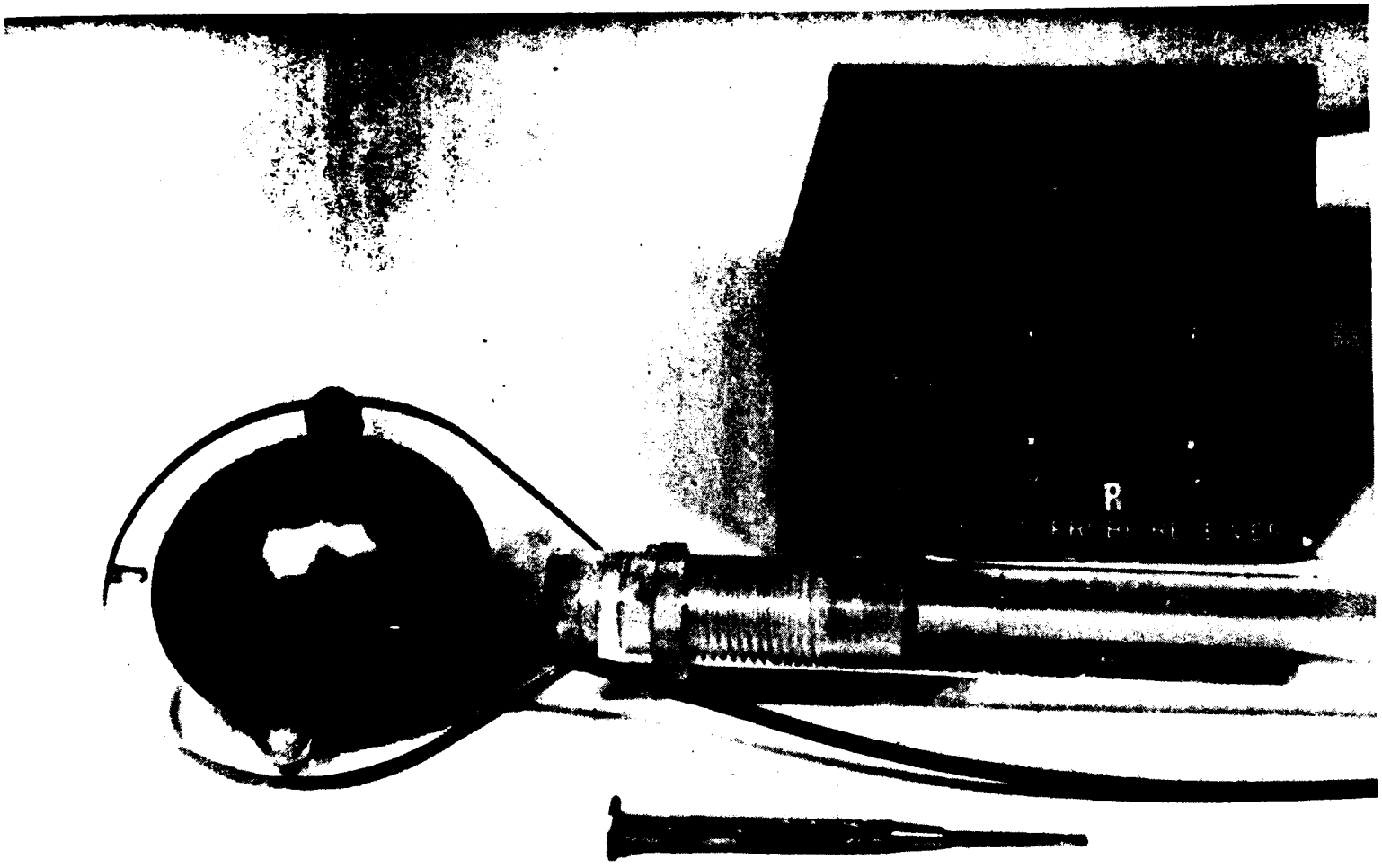


Figure 4. Electric field probe.

Figure 3. Magnetic field probes.

of the applied field can be obtained by means of individual sets of laboratory calibration factors for each probe. By taking three orthogonal measurements (two in the case of the electric field intensity in the earth), the magnitude of the electric or magnetic field (vector sum) is derived by calculating the square root of the sum of the squares of the orthogonal components (RSS value).

The meter used to measure the probes' output voltages was a Hewlett-Packard 3581A Signal Wave Analyzer. The HP 3581A functions as a true rms reading, frequency selective voltmeter, with factory modifications for battery and 1 Hz operation. A measurement bandwidth of 3 Hz was used for single-frequency measurements to discriminate between 60 Hz and 76 Hz fields. To identify the presence of any electromagnetic field levels at harmonics of 60 Hz (i.e., 120 Hz or 180 Hz) measurement bandwidths of 30 Hz and 300 Hz were also used.

The magnetic flux density was measured using a magnetic field probe composed of multi-turned coils of wire wound on ferrite cores and shunted by appropriately chosen resistors to obtain a flat frequency response. Two of the magnetic field probes are shown in Figure 3.

The electric field intensity in the air was measured using an electric field probe[2] consisting of a spherical sensor/transmitter, an optical fiber data link, and a receiver. The electric field probe is shown in Figure 4.

The electric field intensity in the earth was measured with one-meter probe wires using a methodology and geometry as indicated in Figure 5.

Since the Clam Lake transmitter facility was available for testing while the Republic facility was still in the planning stages, different measurement protocols were used for the Wisconsin and Michigan field sites. In Wisconsin, the three electromagnetic fields identified above were measured and transformed as follows:

1. Orthogonal components of each field were measured with each of the two antenna elements operating one at a time at a continuous frequency of 76 Hz and an antenna current of 150 or 250 amperes. 60 Hz fields were measured with both antenna elements off. This totals 24 measurements per location.

2. The orthogonal component measurement data were converted to field levels using the probe calibration factors.

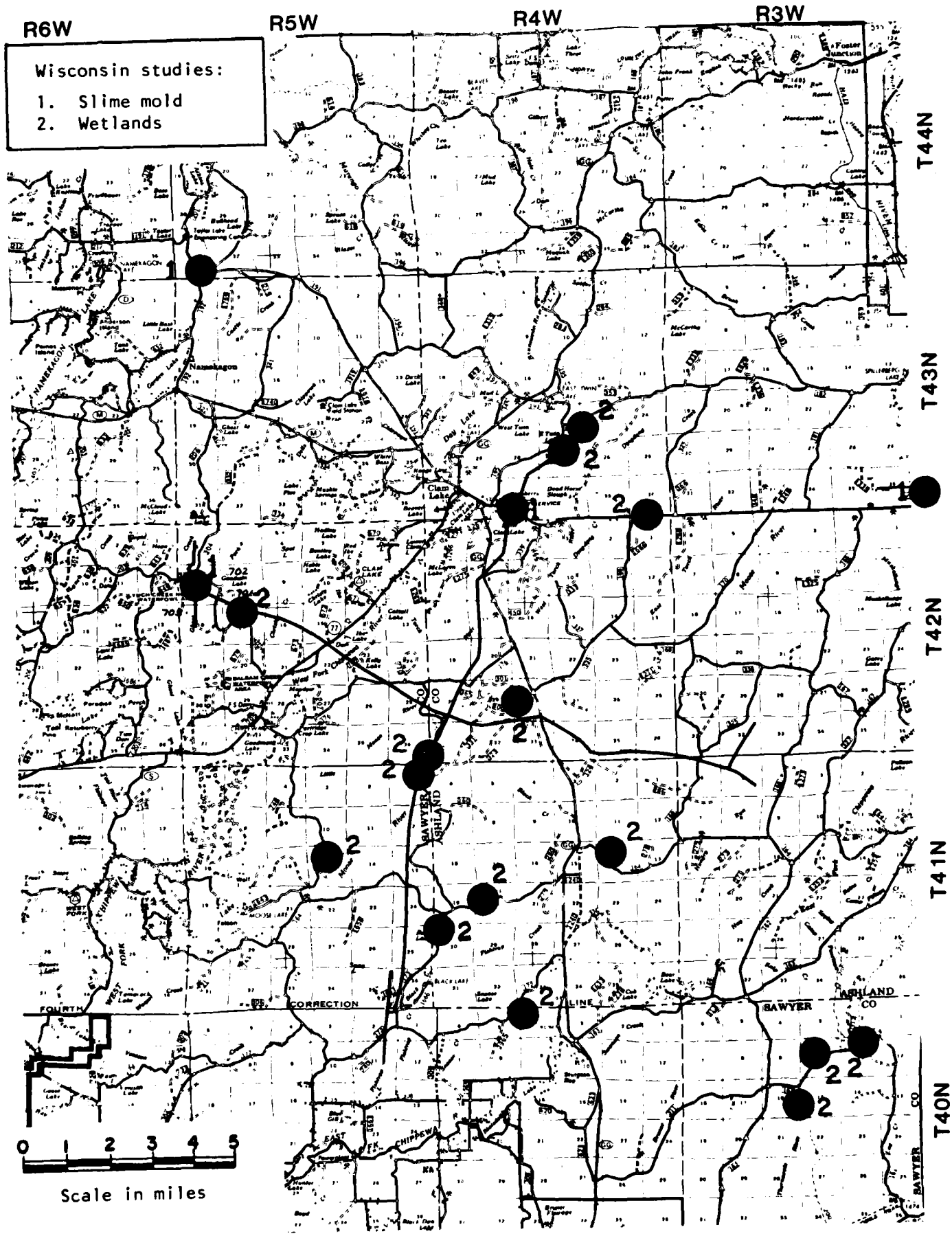


Figure 2. Field sites for Wisconsin ecology studies.

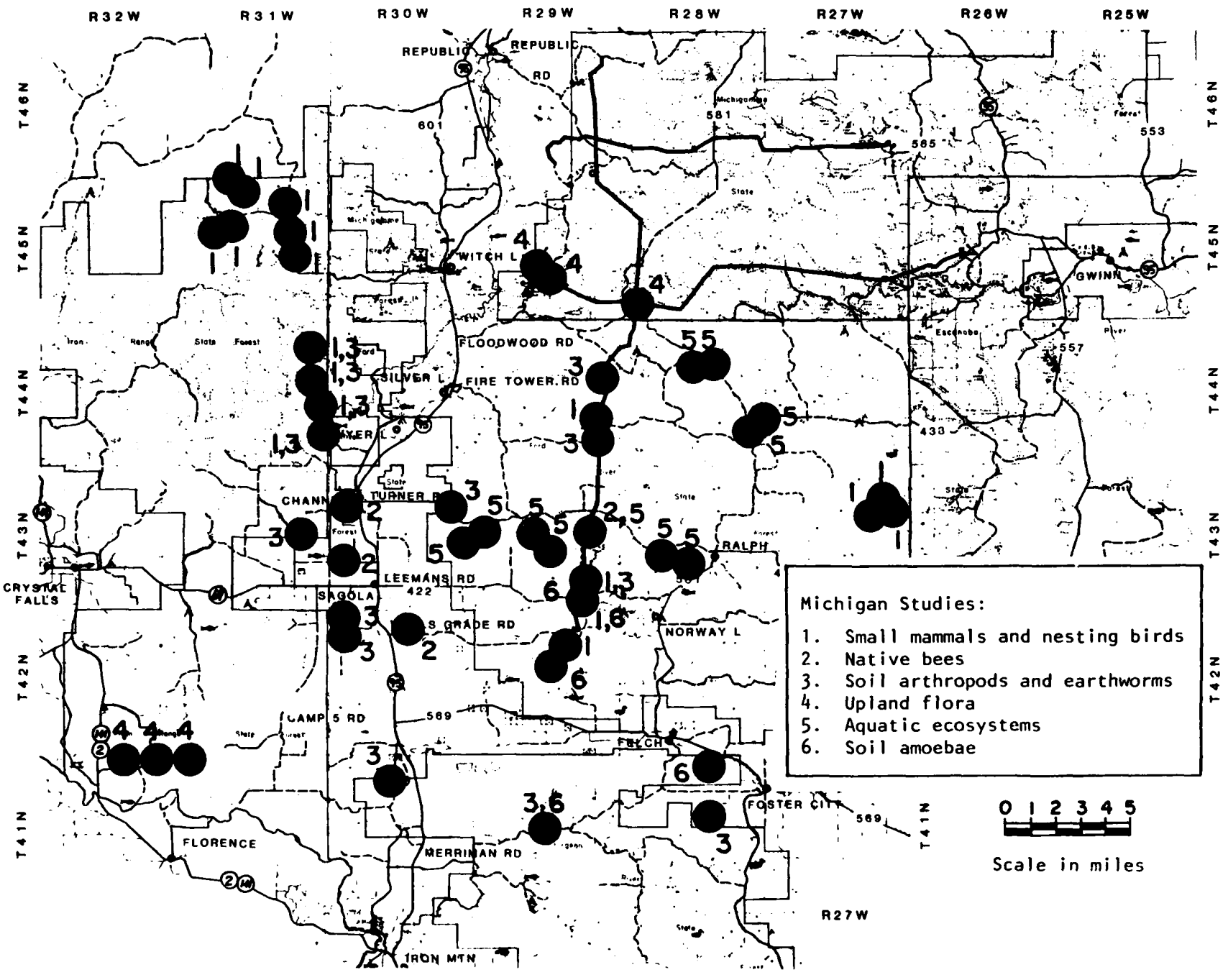


Figure 1. Field sites for Michigan ecology studies.

APPENDIX A
SMALL MAMMALS AND NESTING BIRDS STUDIES

SMALL MAMMALS AND NESTING BIRDS STUDIES

On 23, 24, and 26 May 1983; 9, 14, and 15 June 1983; and 14 July 1983, IITRI field crews made ELF electromagnetic field measurements at 21 measurement points on a total of ten test and control sites for the small mammals and nesting birds study. The positions of these ten sites relative to the proposed Republic Transmitter Facility antenna elements are shown on the composite map in Figure A-1. The site numbers listed on the map are those used by IITRI. Table A-1 provides a cross-reference of IITRI site numbers, investigator site names, and township, range, and section number locations for each site.

TABLE A-1. SITE NO. CROSS-REFERENCE

IITRI Site No.	Investigator's Site Name	Location T	R	S
1T1	Leeman's Road - Test 1	T43N	R29W	23,26
1T2	Cleveland Homestead - Test 2	T44N	R29W	24,25
1T3	Wells Grade - Test 3	T42N	R29W	3,10
1C1A	North Michigamme Res. - Control 1	T44N	R31W	12,13
1C1B	North Branch Ford River	T43N	R27W	11,11/12
1C2A		T45N	R31W	23
1C2B		T45N	R31W	10/11,14
1C2C		T45N	R31W	8,8/9
1C2D	Camp 1 Road - Control 2	T45N	R31W	4
1C3	South Michigamme Res. - Control 3	T44N	R31W	24,24/25

Planned logging activities by Champion Paper Company and proposed changes in the final position of the overhead antenna and antenna ground number 4 have affected activities at site 1T3. At the end of the 1983 field season, the investigators had indicated that the logging activities were under way and would necessitate the location of another suitable test site.

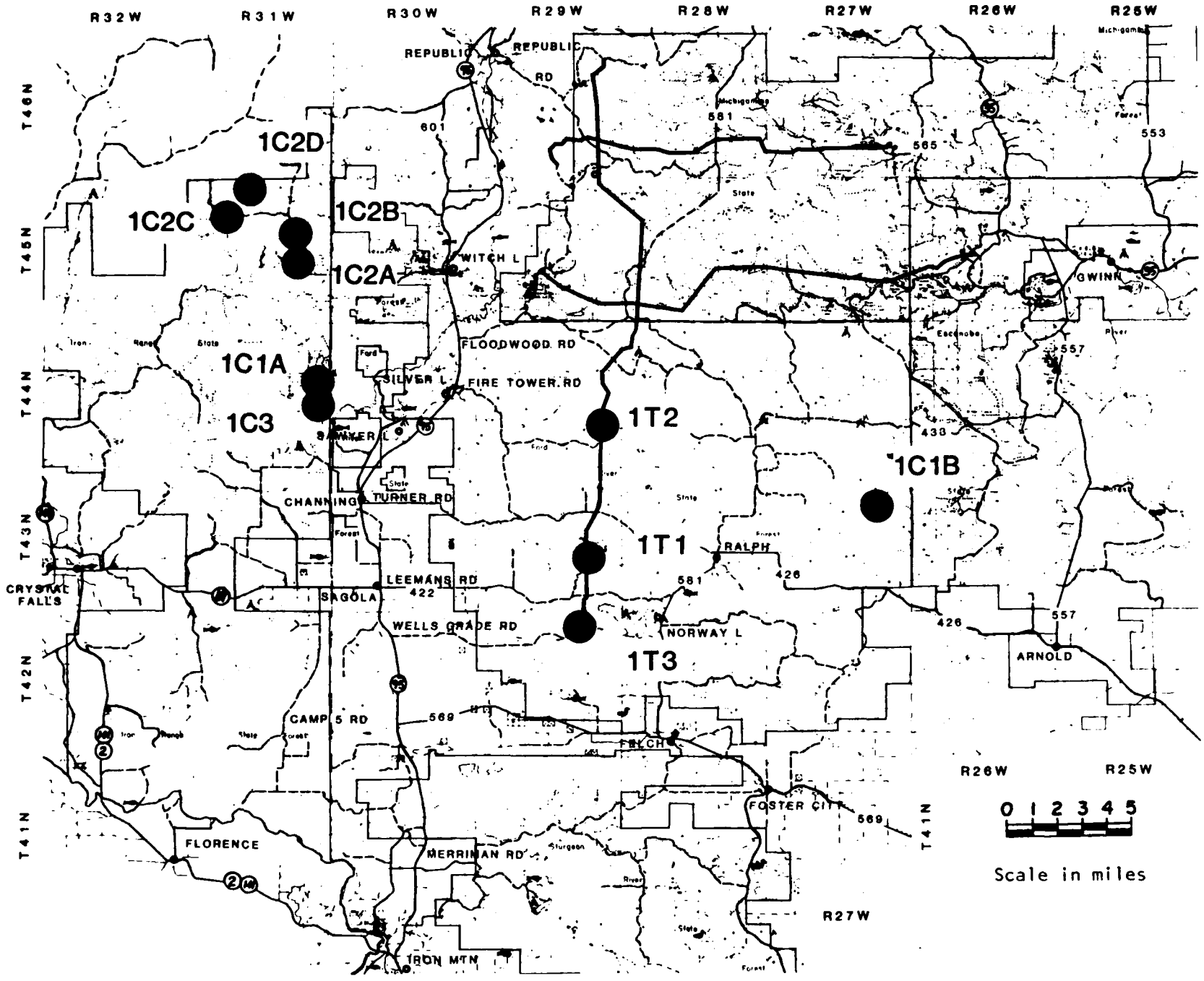


Figure A-1. Positions of test and control sites relative to transmitter facility antenna elements.

Objectives of the small mammals and nesting birds study consist of parental care, nestling growth and maturation, fecundity, homing, activity patterns, embryological development, and metabolic physiology. The electric and magnetic fields in the air are considered important factors to be examined in orientation and other behavior patterns. The electric and magnetic fields in the earth near the surface may be important to other objectives of this study.

Based on conversations and correspondence with the investigators, it has been determined that the pairings of interest are: test site 1T1 with either control site 1C1A or 1C1B; test site 1T2 with any of the control sites 1C2A, 1C2B, 1C2C, or 1C2D; and test site 1T3 with control site 1C3. Site pairings including test site 1T1 were to be used for studies of parental care; pairings including test site 1T2 for census studies; and pairings including test site 1T3 for use with homing, activity patterns, and embryological development studies.

Data listed for the magnitudes of the fields produced by the ELF system were estimated at a frequency of 76 Hz (the expected operating frequency) and based on calculations utilizing the proposed location and operating conditions of the Republic Transmitter Facility antenna elements and the distance to each measurement point. A summary of the measured 60 Hz and estimated 76 Hz data taken at measurement points for each of the sites is given in Table A-2. These summarized data were compiled from the detailed data found in Tables A-4, A-5, and A-6.

The ELF electromagnetic field exposure criteria were applied to the data by computing the field intensity ratios utilized in the mathematical representation of the exposure criteria. The results of this effort are illustrated in Table A-3.

Review of the ratios presented in Table A-3 indicates that pairings of test/control sites 1T1 with 1C1A, 1T1 with 1C1B, 1T2 with 1C2C, and 1T3 with 1C3 will satisfy the exposure criteria. The test/control site pair 1T2/1C2A fails to meet the exposure criteria specification that the ratio R4 for the electric field in the air be less than or equal to ten. The site pair 1T2/1C2D fails to satisfy the exposure criteria specification that the ratio R4 for the electric field in the earth. The site pair 1T2/1C2D could be

considered conditionally acceptable if the northern edge of the study site were moved south, past measurement point 2, to a point where the value of the electric field intensity in the earth is comparable to that measured at point 1.

In summary, the test/control site pairings of 1T1 with 1C1A, 1T1 with 1C1B, 1T2 with 1C2B, 1T2 with 1C2C, and 1T3 with 1C3 are acceptable; the pairing of 1T2 with 1C2D is conditionally acceptable if the southern portion only of control site 1C2D is considered; and the pairing of 1T2 with 1C2A is unacceptable.

TABLE A-2

SUMMARY DATA
ELECTROMAGNETIC FIELD INTENSITIES AND FLUX DENSITIES (1)
SMALL MAMMALS AND NESTING BIRDS STUDY

SITE NO.	MEAS PT	ELECTRIC FIELD IN THE AIR INTENSITY (V/m)		ELECTRIC FIELD IN THE EARTH INTENSITY (mV/m)		MAGNETIC FLUX DENSITY (mG)	
		ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz
1T1	1	35.--> ?	<0.001	75.-->35.	0.090	15.-->1.	0.002
1T1	2	"	"	"	0.021	"	"
1T2	1	"	"	"	0.17	"	<0.001
1T2	2	"	"	"	0.15	"	"
1T3	1	"	"	"	0.36	"	0.004
1T3	2	"	"	"	0.26	"	"
1C1A	1	<0.001	"	1.0	0.059	0.01	<0.001
1C1A	2	"	"	"	0.041	"	"
1C1B	1	"	"	2.0	0.13	"	"
1C1B	2	"	"	"	0.12	"	"
1C1B	3	"	"	"	0.15	"	"
1C2A	1	"	0.014	1.0	0.58	0.02	0.002
1C2B	1	"	<0.001	"	0.046	"	<0.001
1C2B	2	"	"	"	0.26	"	0.003
1C2C	1	"	"	"	0.022	0.01	<0.001
1C2C	2	"	"	"	0.025	"	"
1C2D	1	"	"	"	0.021	"	"
1C2D	2	"	"	"	0.001	"	"
1C2D	3	"	"	"	0.002	"	0.001
1C3	1	"	"	"	0.11	"	<0.001
1C3	2	"	"	"	0.13	"	0.001

1) Values shown are magnitudes determined as the square root of the sum of the squares of the orthogonal field components measured. Data listed for Estimated 76 Hz is based on theoretical analyses using the proposed location and operating conditions of the antenna elements along with the distance to each measurement point.

TABLE A-3

ELF ELECTROMAGNETIC FIELD EXPOSURE CRITERIA
FIELD INTENSITY RATIOS (1)
SMALL MAMMALS AND NESTING BIRDS STUDY

COMPARED SITE NO.S	ELECTRIC FIELD IN THE AIR				ELECTRIC FIELD IN THE EARTH				MAGNETIC FIELD			
	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10
1T1/1C1A	>35000.	>35000.	>35000.	1.0	>35.	>380.	>590.	2.2—>0.4	>100.	>500.	>1000.	2.0
1T1/1C1B	"	"	"	"	>17.	"	>230.	0.8—>0.1	"	"	"	"
1T2/1C2A	"	"	>2500.	14. *	>35.	>200.	>60.	0.3	>50.	>1000.	>500.	0.5
1T2/1C2B	"	"	>35000.	1.0	"	"	>130.	3.7—>0.6	"	"	>300.	1.0—>0.3
1T2/1C2C	"	"	"	"	"	"	>1400.	7.7—>6.0	>100.	"	>1000.	1.0
1T2/1C2D	"	"	"	"	"	"	>1600.	170.->7.*	"	"	"	"
1T3/1C3	"	"	"	"	"	>95.	>260.	3.3—>2.0	"	>250.	"	4.0

1) R1 = Test Site (76 Hz) / Control Site (76 Hz) R1 >= 10.
R2 = Test Site (76 Hz) / Test Site (60 Hz) R2 >= 10.
R3 = Test Site (76 Hz) / Control Site (60 Hz) R3 >= 10.
R4 = Test Site (60 Hz) / Control Site (60 Hz) 0.1 <= R4 <= 10.

* Does not meet the exposure criterion specification.

TABLE A-4

ELECTRIC FIELD INTENSITY IN AIR
SMALL MAMMALS AND NESTING BIRDS STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN AIR (1) (VOLTS/METER)			
		N-S	E-W	VERT	RSS
1T1	1	A	A	A	A
1T1	2	A	A	A	A
1T2	1	A	A	A	A
1T2	2	A	A	A	A
1T3	1	A	A	A	A
1T3	2	A	A	A	A
1C1A	1	A	A	A	A
1C1A	2	A	A	A	A
1C1B	1	A	A	A	A
1C1B	2	A	A	A	A
1C1B	3	A	A	A	A
1C2A	1	A	A	0.014	0.014
1C2B	1	A	A	A	A
1C2B	2	A	A	A	A
1C2C	1	A	A	A	A
1C2C	2	A	A	A	A
1C2D	1	A	A	A	A
1C2D	2	A	A	A	A
1C2D	3	A	A	A	A
1C3	1	A	A	A	A
1C3	2	A	A	A	A

A) <0.001 volt/meter

1) N-S, E-W, and VERT are electric field intensities in air in the north-south, east-west, and vertical directions, respectively.
The composite magnitude of the electric field intensity in air is derived from the square root of the sum of the squares and is denoted by RSS.

TABLE A-5

ELECTRIC FIELD INTENSITY IN EARTH
SMALL MAMMALS AND NESTING BIRDS STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN EARTH (1) (MILLIVOLTS/METER)		
		N-S	E-W	RSS
1T1	1	0.080	0.042	0.090
1T1	2	0.012	0.017	0.021
1T2	1	0.12	0.13	0.17
1T2	2	0.10	0.11	0.15
1T3	1	0.18	0.31	0.36
1T3	2	0.11	0.23	0.26
1C1A	1	0.042	0.041	0.059
1C1A	2	0.032	0.025	0.041
1C1B	1	0.072	0.11	0.13
1C1B	2	0.058	0.11	0.12
1C1B	3	0.050	0.14	0.15
1C2A	1	0.36	0.46	0.58
1C2B	1	0.017	0.043	0.046
1C2B	2	0.21	0.16	0.26
1C2C	1	0.008	0.021	0.022
1C2C	2	0.012	0.022	0.025
1C2D	1	0.017	0.013	0.021
1C2D	2	A	0.001	0.001
1C2D	3	0.001	0.002	0.002
1C3	1	0.11	0.014	0.11
1C3	2	0.12	0.050	0.13

A) <0.001 millivolt/meter

1) N-S and E-W are electric field intensities in earth in the north-south and east-west directions, respectively.
The composite magnitude of the electric field intensity in the earth is derived from the square root of the sum of the squares and is denoted as RSS.

TABLE A-6

MAGNETIC FLUX DENSITY
SMALL MAMMALS AND NESTING BIRDS STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz MAGNETIC FLUX DENSITY (1) (MILLIGAUSS)			
		N-S	E-W	VERT	RSS
1T1	1	A	A	0.002	0.002
1T1	2	0.002	A	A	0.002
1T2	1	A	A	A	A
1T2	2	A	A	A	A
1T3	1	0.002	0.001	0.003	0.004
1T3	2	0.002	A	0.004	0.004
1C1A	1	A	A	A	A
1C1A	2	A	A	A	A
1C1B	1	A	A	A	A
1C1B	2	A	A	A	A
1C1B	3	A	A	A	A
1C2A	1	A	A	0.002	0.002
1C2B	1	A	A	A	A
1C2B	2	0.001	A	0.003	0.003
1C2C	1	A	A	A	A
1C2C	2	A	A	A	A
1C2D	1	A	A	A	A
1C2D	2	A	A	A	A
1C2D	3	0.001	0.001	A	0.001
1C3	1	A	A	A	A
1C3	2	A	0.001	A	0.001

A) <0.001 milligauss

1) N-S, E-W, and VERT are magnetic flux densities in the north-south, east-west, and vertical directions, respectively.
The composite magnitude of the magnetic flux density is derived from the square root of the sum of the squares and is denoted by RSS.

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APPENDIX B
NATIVE BEES STUDIES

NATIVE BEES STUDIES

On 25 May and 13 July 1983, IITRI field crews made ELF electromagnetic field measurements at a total of six test and control sites for the native bee study. The positions of these six sites relative to the proposed Republic Transmitter Facility antenna elements are shown on the composite map in Figure B-1. The site numbers listed on the map are those used by IITRI. Table B-1 provides a cross-reference of IITRI site numbers, investigator site names, and township, range, and section number locations for each site.

TABLE B-1. SITE NO. CROSS-REFERENCE

IITRI Site No.	Investigator's Site Name	Location T	R	S
2T1	Ford River Test	T43N	R29W	14
2T2		T43N	R29W	14
2C1	Channing Control 1	T43N	R30W	18
2C2	Channing Control 2	T43N	R30W	18
2C3	Sagola Control	T43N	R30W	33
2C4	County Line Road Control	T43N	R30W	19

The native bee study incorporates studies of both nesting and development traits. The electric and magnetic fields present in the air are considered the most important factors in the orientation and site tenacity of bees during their nesting cycle. The electric and magnetic fields in the earth near the surface may be of importance in developmental studies.

Data listed for the magnitudes of the fields produced by the ELF system were estimated at a frequency of 76 Hz (the expected operating frequency) and based on calculations utilizing the proposed location and operating conditons of the Republic Transmitter Facility antenna elements and the distance to each measurement point. A summary of the measured and estimated data taken for each of the sites is given in Table B-2. These summarized data were compiled from the detailed data found in Tables B-4, B-5, and B-6.

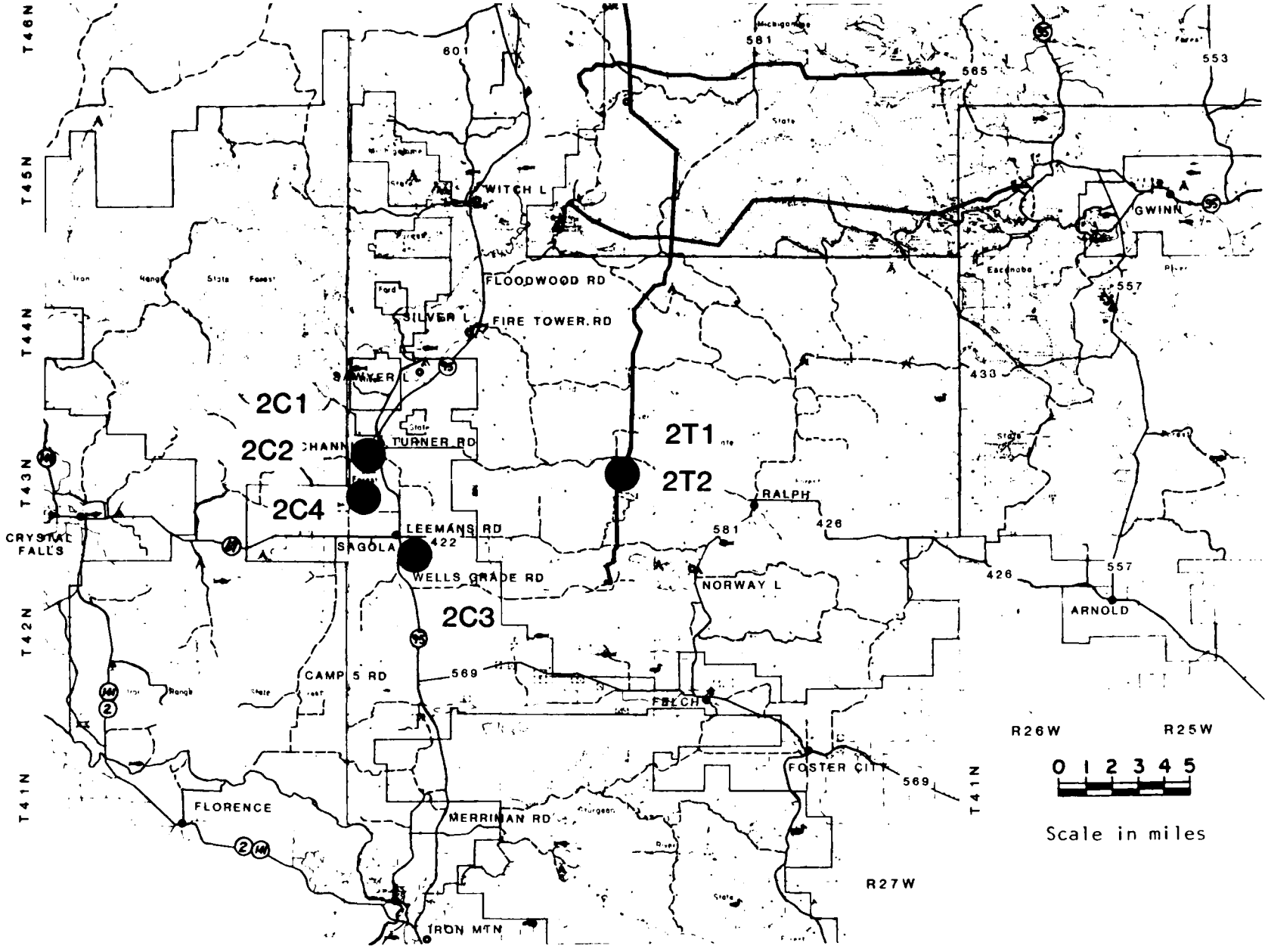

Figure B-1. Positions of test and control sites relative to transmitter facility antenna elements.

TABLE C-4

ELECTRIC FIELD INTENSITY IN AIR
SOIL ARTHROPODS AND EARTHWORMS STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN AIR (1) (VOLTS/METER)			
		N-S	E-W	VERT	RSS
3T1	1	A	A	A	A
3T2	1	A	A	A	A
3T3	1	A	A	A	A
3C1	1	A	A	A	A
3C2	1	A	A	A	A
3C3	1	A	A	A	A
3C4	1	A	A	A	A
3C5	1	A	A	A	A
3C6	1	(2)	(2)	(2)	(2)
3C7	1	A	A	A	A
3C8	1	A	A	A	A
3C9	1	A	A	A	A

A) <0.001 volt/meter

1) N-S, E-W, and VERT are electric field intensities in air in the north-south, east-west, and vertical directions, respectively.
The composite magnitude of the electric field intensity in air is derived from the square root of the sum of the squares and is denoted by RSS.

2) Data not taken

TABLE C-3

ELF ELECTROMAGNETIC FIELD EXPOSURE CRITERIA FIELD INTENSITY RATIOS (1)

SOIL ARTHROPODS AND EARTHWORMS STUDIES

COMPARED SITE NOS	ELECTRIC FIELD IN THE AIR				ELECTRIC FIELD IN THE EARTH				MAGNETIC FIELD			
	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10
T1/3C1	>3500.	>3500.	>3500.	1.0	>45.	>500.	>1800.	3.6	>75.	>1500.	>500.	0.3
T1/3C2	"	"	"	"	>90.	"	>140.	0.3	"	"	>375.	0.25
T1/3C3	"	"	"	"	>45.	"	>1000.	2.1	"	"	>1500.	1.0
T1/3C4	"	"	"	"	"	"	>400.	0.8	"	"	"	"
T1/3C5	"	"	"	"	>11.	"	>700.	1.4	>50.	"	"	"
T1/3C6	---	---	---	---	---	---	---	---	---	---	---	---
T1/3C7	---	---	---	---	---	---	---	---	---	---	---	---
T1/3C8	>3500.	>3500.	>3500.	1.0	>90.	>500.	>40.	0.08 *	>75.	>1500.	>750.	0.5
T1/3C9	"	"	"	"	>45.	"	>160.	0.3	"	"	>1500.	1.0
T2/3C1	>35000.	>35000.	>35000.	"	>50.	>450.	>2000.	4.6	>150.	>3000.	>1000.	0.3
T2/3C2	"	"	"	"	>100.	"	>150.	0.3	"	"	>750.	0.25
T2/3C3	"	"	"	"	>50.	"	>1200.	2.7	"	"	>3000.	1.0
T2/3C4	"	"	"	"	"	"	>450.	1.0	"	"	"	"
T2/3C5	"	"	"	"	>12.	"	>790.	1.7	>100.	"	"	"
T2/3C6	---	---	---	---	---	---	---	---	---	---	---	---
T2/3C7	---	---	---	---	---	---	---	---	---	---	---	---
T2/3C8	>35000.	>35000.	>35000.	1.0	>100.	>450.	>45.	0.1	>150.	>3000.	>1500.	0.5
T2/3C9	"	"	"	"	>50.	"	>170.	0.4	"	"	>3000.	1.0
T3/3C1	>100.	>100.	>100.	"	>35.	>250.	>1400.	5.8	>50.	>1000.	>300.	0.3
T3/3C2	"	"	"	"	>70.	"	>100.	0.4	"	"	250.	0.25
T3/3C3	"	"	"	"	>35.	"	>850.	3.4	"	"	>1000.	1.0
T3/3C4	"	"	"	"	"	"	>320.	1.3	"	"	"	"
T3/3C5	"	"	"	"	>8.8 *	"	>550.	2.2	>33.	"	"	"
T3/3C6	---	---	---	---	---	---	---	---	---	---	---	---
T3/3C7	---	---	---	---	---	---	---	---	---	---	---	---
T3/3C8	>100.	>100.	>100.	1.0	>75.	>250.	>30.	0.1	50.	>1000.	500.	0.5
T3/3C9	"	"	"	"	>35.	"	>120.	0.5	"	"	1000.	1.0

1) R1 = Test Site (76 Hz) / Control Site (76 Hz) R1 >= 10.
R2 = Test Site (76 Hz) / Test Site (60 Hz) R2 >= 10.
R3 = Test Site (76 Hz) / Control Site (60 Hz) R3 >= 10.
R4 = Test Site (60 Hz) / Control Site (60 Hz) 0.1 <= R4 <= 10.

* Does not meet the exposure criterion specification.

TABLE C-2

SUMMARY DATA
ELECTROMAGNETIC FIELD INTENSITIES AND FLUX DENSITIES (1)
SOIL ARTHROPODS AND EARTHWORMS STUDIES

SITE NO.	MEAS PT	ELECTRIC FIELD IN THE AIR INTENSITY (V/m)		ELECTRIC FIELD IN THE EARTH INTENSITY (mV/m)		MAGNETIC FLUX DENSITY (mG)	
		ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz
3T1	1	3.5--> ?	<0.001	60.-->45.	0.087	5.0-->1.5	0.001
3T2	1	35.--> ?	"	75.-->50.	0.11	15.-->3.0	<0.001
3T3	1	0.1--> ?	"	40.-->35.	0.14	1.0	"
3C1	1	<0.001	"	1.0	0.024	0.02	0.003
3C2	1	"	"	0.5	0.32	"	0.004
3C3	1	"	"	1.0	0.041	"	<0.001
3C4	1	"	"	"	0.11	"	"
3C5	1	"	"	4.0	0.063	0.03	0.001
3C6	1	"	A	1.0	0.31	0.02	0.060
3C7	1	"	<0.001	"	0.073	"	0.007
3C8	1	"	"	0.5	1.1	"	0.002
3C9	1	"	"	1.0	0.28	"	0.001

A) Measurement data not taken.

1) Values shown are magnitudes determined as the square root of the sum of the squares of the orthogonal field components measured. Data listed for Estimated 76 Hz is based on theoretical analyses using the proposed location and operating conditions of the antenna elements along with the distance to each measurement point.

site pair 3T3/3C5 fails to meet the exposure criteria requirement of being greater than or equal to ten. The ratio of Test(60)/Control(60) for the electric field in the earth for the site pair 3T1/3C8 fails to meet the exposure criteria requirement of being greater than or equal to one tenth.

The pairing of test site 3T1, 3T2, or 3T3 with either control site 3C6 or 3C7 will not satisfy the exposure criteria due to the presence of significant measured levels of 60 Hz harmonics at these control sites.

In summary, the test/control site pairings of 3T1, 3T2, or 3T3 with any of 3C1, 3C2, 3C3, 3C4, or 3C9 and pairings of 3T1/3C5, 3T2/3C5, 3T2/3C8 are conditionally acceptable, and the pairings of control sites 3C6 or 3C7 with any of the test sites 3T1, 3T2, or 3T3 are unacceptable.

The soil arthropods and earthworms studies will monitor species composition, population age structure, and distribution. The electric and magnetic fields in the earth are considered the most important electromagnetic factors influencing soil biota. The electric field in the air is not expected to have a significant impact on the objectives of this study.

Data listed for the magnitudes of the fields produced by the ELF system were estimated at a frequency of 76 Hz (the expected operating frequency) and based on calculations utilizing the proposed location and operating conditions of the Republic Transmitter Facility antenna elements and the distance to each measurement point. In addition to 60 Hz, second, fourth, and fifth order harmonics of 60 Hz (i.e., 120, 240, and 300 Hz) were examined for each site. The field intensity levels of these higher order harmonics were recorded if above the detectable limits of the measurement equipment. The magnetic and electric field intensities in the earth measured at control sites 3C7 and 3C8 at frequencies of 120, 240, and 300 Hz were found to be sizeable compared to the principal frequency (60 Hz). The electric field intensity in the earth measured at a frequency of 120 Hz was approximately 30 percent of that measured at 60 Hz at both of these control sites. Field intensity levels at higher order harmonics of 60 Hz were not detectable at any of the other test or control sites examined. A summary of the measured 60 Hz and estimated 76 Hz data taken at measurement points for each of the sites is given in Table C-2. These summarized data were compiled from the detailed data found in Tables C-4, C-5, and C-6.

The ELF electromagnetic field exposure criteria were applied to the data (excluding the field intensity ratios for test/control site pairs involving control sites with measurable harmonics of 60 Hz) by computing the field intensity ratios utilized in the mathematical representation of the exposure criteria. The results of this effort are illustrated in Table C-3.

Review of the ratios presented in Table C-3 indicates that any pairing of test sites 3T1, 3T2, or 3T3 with control sites 3C1, 3C2, 3C3, 3C4, or 3C9 will satisfy the exposure criteria. Site pairs 3T1/3C5, 3T2/3C5, 3T2/3C8, and 3T3/3T8 also satisfy the exposure criteria.

Site pairs 3T3/3C5 and 3R1/3C8 are considered conditionally acceptable. The ratio of Test(76)/Control(76) for the electric field in the earth for the

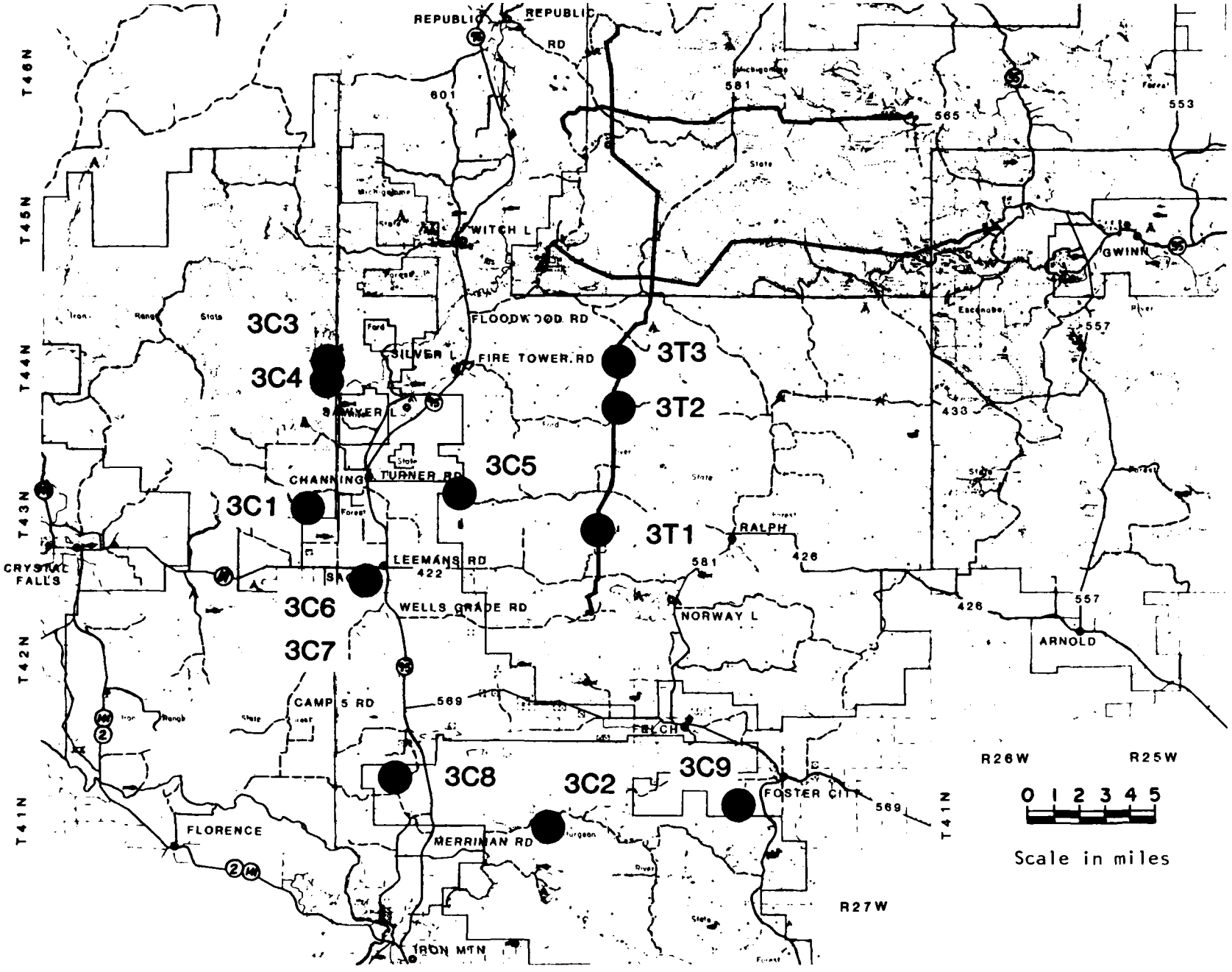

Figure C-1. Positions of test and control sites relative to transmitter facility antenna elements.

SOIL ARTHROPODS AND EARTHWORMS STUDIES

On 6 June and 13 July 1983, IITRI field crews made ELF electromagnetic field measurements at a total of twelve test and control sites for the soil arthropods and earthworms studies. The positions of these twelve sites relative to the proposed Republic Transmitter Facility antenna elements are shown on the composite map in Figure C-1. The site numbers listed on the map are those used by IITRI. Table C-1 provides a cross-reference of IITRI site numbers, investigator site names, and township, range, and section number locations for each site.

TABLE C-1. SITE NO. CROSS-REFERENCE

IITRI Site No.	Investigator's Site Name	Location T	R	S
3T1	Sagola Site - Leeman's Road	T43N	R29W	23
3T2	South Silver Lake Site	T44N	R29W	25
3T3	North Silver Lake Site	T44N	R29W	13
3C1	10th Street Control	T43N	R31W	14
3C2	Merriman Road Site	T41N	R29W	21
3C3	Iron County North	T44N	R31W	13
3C4	Iron County South	T44N	R31W	24
3C5	Turner Road Site	T43N	R30W	11
3C6		T43N	R30W	31
3C7		T43N	R30W	31
3C8	Randville Site	T41N	R30W	9
3C9	Foster City Site	T41N	R28W	15

APPENDIX C
SOIL ARTHROPODS AND EARTHWORMS STUDIES

TABLE B-6

MAGNETIC FLUX DENSITY
NATIVE BEES STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz MAGNETIC FLUX DENSITY (1) (MILLIGAUSS)			
		N-S	E-W	VERT	RSS
2T1	1	A	A	0.001	0.001
2T2	1	A	0.001	0.002	0.002
2C1	1	0.009	0.016	0.014	0.023
2C2	1	A	0.005	0.005	0.007
2C3	1	0.003	0.001	0.002	0.004
2C4	1	0.002	0.003	0.002	0.004

A) <0.001 milligauss

1) N-S, E-W, and VERT are magnetic flux densities in the north-south, east-west, and vertical directions, respectively.
The composite magnitude of the magnetic flux density is derived from the square root of the sum of the squares and is denoted by RSS.

TABLE B-5

ELECTRIC FIELD INTENSITY IN EARTH
NATIVE BEES STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN EARTH (1) (MILLIVOLTS/METER)		
		N-S	E-W	RSS
2T1	1	0.15	0.18	0.23
2T2	1	0.068	0.021	0.071
2C1	1	6.4	1.0	6.5
2C2	1	1.8	0.060	1.8
2C3	1	0.087	0.080	0.12
2C4	1	0.009	0.007	0.011

1) N-S and E-W are electric field intensities in earth in the north-south and east-west directions, respectively.
The composite magnitude of the electric field intensity in the earth is derived from the square root of the sum of the squares and is denoted as RSS.

TABLE B-4

ELECTRIC FIELD INTENSITY IN AIR
NATIVE BEES STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN AIR (1) (VOLTS/METER)			
		N-S	E-W	VERT	RSS
2T1	1	A	A	A	A
2T2	1	A	A	A	A
2C1	1	0.011	0.002	0.044	0.045
2C2	1	0.003	0.004	0.018	0.018
2C3	1	0.004	0.004	0.14	0.14
2C4	1	A	A	A	A

A) <0.001 volt/meter

1) N-S, E-W, and VERT are electric field intensities in air in the north-south, east-west, and vertical directions, respectively.
The composite magnitude of the electric field intensity in air is derived from the square root of the sum of the squares and is denoted by RSS.

TABLE B-3

ELF ELECTROMAGNETIC FIELD EXPOSURE CRITERIA
FIELD INTENSITY RATIOS (1)
NATIVE BEES STUDY

COMPARED SITE NO.S	ELECTRIC FIELD IN THE AIR				ELECTRIC FIELD IN THE EARTH				MAGNETIC FIELD			
	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10
2T1/2C1	>2000.	>2000.	>40.	<0.02 *	55.	240.	9.6*	0.04 *	>70.	3500.	140.	0.04 *
2T1/2C2	"	"	>120.	<0.06 *	"	"	31.	0.13	"	"	490.	0.14
2T1/2C3	"	"	>20.	<0.01 *	"	"	460.	1.9	>35.	"	875.	0.25
2T1/2C4	"	"	>2000.	1.0	"	"	5000.	21. *	>70.	"	875.	0.25
2T2/2C1	>100000.	>100000.	>40.	<0.02 *	85.	1200.	12.	0.01 *	>600.	15000.	1400.	0.09 *
2T2/2C2	"	"	>120.	<0.06 *	"	"	48.	0.04 *	"	"	4200.	0.28
2T2/2C3	"	"	>20.	<0.01 *	"	"	720.	0.60	>300.	"	7500.	0.50
2T2/2C4	"	"	>2000.	1.0	"	"	7800.	6.5	>600.	"	7500.	0.50

1) R1 = Test Site (76 Hz) / Control Site (76 Hz) R1 >= 10.
R2 = Test Site (76 Hz) / Test Site (60 Hz) R2 >= 10.
R3 = Test Site (76 Hz) / Control Site (60 Hz) R3 >= 10.
R4 = Test Site (60 Hz) / Control Site (60 Hz) 0.1 <= R4 <= 10.

* Does not meet the exposure criterion specification.

TABLE B-2

SUMMARY DATA
ELECTROMAGNETIC FIELD INTENSITIES AND FLUX DENSITIES (1)
NATIVE BEES STUDY

SITE NO.	MEAS PT	ELECTRIC FIELD IN THE AIR INTENSITY (V/m)		ELECTRIC FIELD IN THE EARTH INTENSITY (mV/m)		MAGNETIC FLUX DENSITY (mG)	
		MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz
2T1	1	<0.001	2.0	0.23	55.	0.001	3.5
2T2	1	<0.001	120.	0.071	85.	0.002	30.
2C1	1	0.045	<0.001	6.5	1.	0.023	<0.05
2C2	1	0.018	"	1.8	"	0.007	"
2C3	1	0.14	"	0.12	"	0.004	<0.1
2C4	1	<0.001	"	0.011	"	0.004	<0.05

1) Values shown are magnitudes determined as the square root of the sum of the squares of the orthogonal field components measured. Data listed for Estimated 76 Hz is based on theoretical analyses using the proposed location and operating conditions of the antenna elements along with the distance to each measurement point.

The ELF electromagnetic field exposure criteria were applied to the data by computing the field intensity ratios utilized in the mathematical reperesentation of the exposure criteria. The results of this effort are illustrated in Table B-3.

Review of the ratios presented in Table B-3 indicates that the only test/control site pair which meets all of the exposure criteria is the pair 2T2/2C4. Assuming that the electromagnetic fields of greatest interest to the native bee study are those most likely to affect behavior, (i.e., the electric and magnetic fields in the air), then sites 2C1 and 2C3 should no longer be considered since they do not form acceptable pairs with either of the two test sites.

The magnitude of the 60 Hz electric field in the air at control sites 2C1 and 2C3 and the 60 Hz magnetic field at site 2C1 are about two orders of magnitude higher than at either test site 2T1 or 2T2. The pairing of control site 2C4 with test site 2T1 is conditionally acceptable, since the magnitude of the 60 Hz electric field in the earth at site 2T1 is 21 times higher than at site 2C4.

Control site 2C2 when paired with either test site 2T1 or 2T2 is also conditionally acceptable, as the magnitude of the 60 Hz electric field in the air at site 2C2 (0.019V/m) is more than 18 times greater than at the test sites. These electric field data were measured during the summer months, when the trees and other vegetation were in full foliage. The magnitude of the electric field may increase (making site 2C2 even less desirable) as the seasons change, due to a decrease in the effective shunting of the electric field in the air by foliage. The principal source of the 60 Hz transverse electric field at control site 2C2 is the nearby power distribution line which is energized at 7.2 kV (a higher voltage than the ELF system antenna elements will have). Control site 2C2 has an additional conditionally acceptable relationship when paired with test site 2T2, since the 60 Hz electric field in the earth at site 2C2 is 25 times higher than at site 2T2.

In summary, the test/control site pairing of site 2T2 with 2C4 is acceptable; pairings of site 2T1 with 2C2 or 2C4 and of site 2T2 with 2C2 are conditionally acceptable; and pairings of either site 2T1 or 2T2 with 2C1 or 2C3 are unacceptable.

TABLE C-5

ELECTRIC FIELD INTENSITY IN EARTH
SOIL ARTHROPODS AND EARTHWORMS STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN EARTH (1) (MILLIVOLTS/METER)		
		N-S	E-W	RSS
3T1	1	0.074	0.046	0.087
3T2	1	0.070	0.080	0.11
3T3	1	0.078	0.12	0.14
3C1	1	0.016	0.018	0.024
3C2	1	0.11	0.30	0.32
3C3	1	0.032	0.025	0.041
3C4	1	0.11	0.014	0.11
3C5	1	0.044	0.045	0.063
3C6	1	0.018	0.31	0.31
3C7	1	0.022	0.070	0.073
3C8	1	1.0	0.35	1.1
3C9	1	0 .8	0.26	0.28

1) N-S and E-W are electric field intensities in earth in the north-south and east-west directions, respectively.
The composite magnitude of the electric field intensity in the earth is derived from the square root of the sum of the squares and is denoted as RSS.

TABLE C-6

MAGNETIC FLUX DENSITY
SOIL ARTHROPODS AND EARTHWORMS STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz MAGNETIC FLUX DENSITY (1) (MILLIGAUSS)			
		N-S	E-W	VERT	RSS
3T1	1	A	A	0.001	0.001
3T2	1	A	A	A	A
3T3	1	A	A	A	A
3C1	1	0.002	0.002	A	0.003
3C2	1	0.003	A	0.001	0.004
3C3	1	A	A	A	A
3C4	1	A	A	A	A
3C5	1	A	A	0.001	0.001
3C6	1	0.003	0.006	0.060	0.060
3C7	1	0.003	0.003	0.005	0.007
3C8	1	0.001	0.001	0.002	0.002
3C9	1	0.001	A	0.001	0.001

A) <0.001 milligauss

1) N-S, E-W, and VERT are magnetic flux densities in the north-south, east-west, and vertical directions, respectively.
The composite magnitude of the magnetic flux density is derived from the square root of the sum of the squares and is denoted by RSS.

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APPENDIX D
UPLAND FLORA STUDIES

UPLAND FLORA STUDIES

On 7 June and 14 July 1983, IITRI field crews made ELF electromagnetic field measurements at a total of five test and control sites for the upland flora studies. The positions of these five sites relative to the proposed Republic Transmitter Facility antenna elements are shown on the composite map in Figure D-1. The site numbers listed on the map are those used by IITRI. Table D-1 provides a cross-reference of IITRI site numbers, investigator site names, and township, range, and section number locations for each site.

TABLE D-1. SITE NO. CROSS-REFERENCE

IITRI Site No.	Investigators Site Name	Location T	R	S
4T1	Martell's Lake (buried) - EP	T45N	R29W	21/28
4T2	Martell's Lake (overhead) - ML	T45N	R29W	28
4T3		T45N	R28W	31
4C1-1	Paint Pond Road Control - 1	T41N	R32W	3
4C1-2	Paint Pond Road Control - 2	T41N	R32W	3
4C1-3	Paint Pond Road Control - 3	T41N	R32W	3/10
4C1-4	Paint Pond Road Control - 4	T41N	R32W	3
4C1-5	Paint Pond Road Control - 5	T41N	R32W	3
4C2	Stager Lake Control - CS	T41N	R32W	4

The major themes of the upland flora studies are the functional and structural aspects of organic material cycling. These studies will investigate and characterize trees, herbaceous plants, and microfloral populations. The electric and magnetic fields in the earth are considered important electromagnetic factors influencing soil biota and processes. The electric and magnetic fields in the air can influence any object extending above the surface. Since the electric field in the air can be effectively shunted by trees or plants on the perimeter of a given study plot, special care was taken in specifying the electric field intensity across the plot.

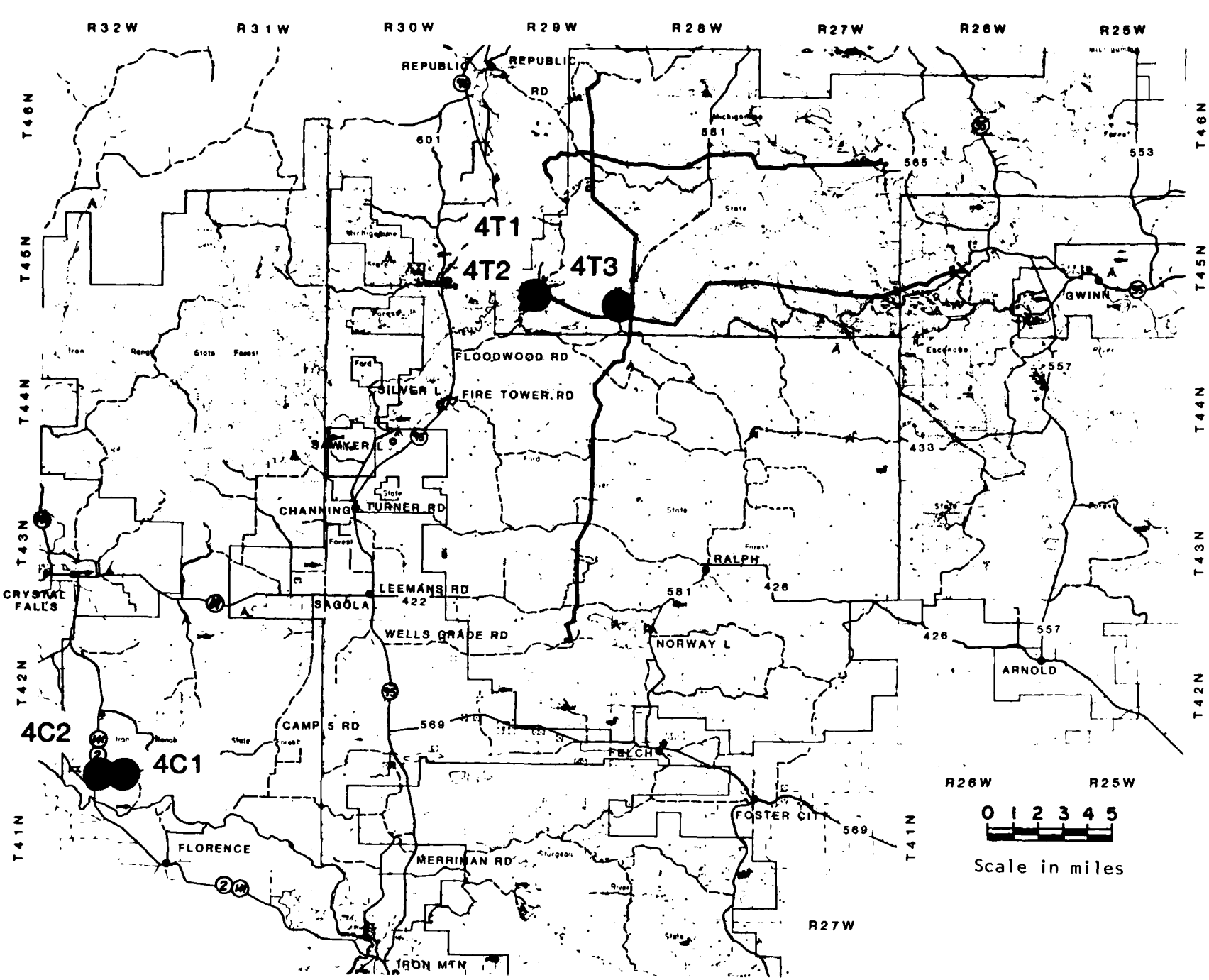

Figure D-1. Positions of test and control sites relative to transmitter facility antenna elements.

Data listed for the magnitudes of the fields produced by the ELF system were estimated at a frequency of 76 Hz (the expected operating frequency) and based on calculations utilizing the proposed location and operating conditions of the Republic Transmitter Facility antenna elements and the distance to each measurement point. A summary of the measured 60 Hz and estimated 76 Hz data taken at measurement points for each of the sites is given in Table D-2. These summarized data were compiled from the detailed data found in Tables D-4, D-5, and D-6.

The ELF electromagnetic field exposure criteria were applied to the data by computing the field intensity ratios utilized in the mathematical representation of the exposure criteria. The results of this effort are illustrated in Table D-3. In the case of control site 4C1, each of the individual measurement points is compared to the test sites. This is done in an effort to illustrate the exposure criteria acceptability, or lack thereof, of the outside perimeter of the area indicated as being biologically acceptable as a control site for the upland flora studies.

Review of the ratios presented in Table D-3 indicates that any pairing of test sites 4T1, 4T2, or 4T3 with control site measurement points 4C1-1, 4C1-4, or 4C1-5 will satisfy the exposure criteria. Pairings of any of the test sites with control site measurement points 4C1-2 or 4C1-3 will not satisfy the ratio R4 for either the electric field in the earth or the magnetic field. Pairings with measurement point 4C1-2 do not satisfy the ratio R4 for the magnetic field due to its location relative to a nearby high voltage transmission line. Pairings with measurement point 4C1-3 do not satisfy the ratio R4 for the electric field in the earth due to the relatively low measured 60 Hz field intensity level at this point.

Site pairings with control site 4C2 do not satisfy the ratio R4 for the electric field in the earth. This is due to the relatively low measured 60 Hz electric field intensity at this control site. The pairing of test site 4T3 with control site 4C2 is conditionally acceptable.

In summary, the test/control site pairing of 4T1, 4T2, or 4T3 with 4C1 is acceptable provided that the final location of control study plots within site 4C1 lie within a triangular region with corners at 4C1-1, 4C1-4, and 4C1-5; the pairing of site 4T3 with 4C2 is conditionally acceptable; and the pairing of site 4T1 or 4T2 with site 4C2 is unacceptable.

TABLE D-2

SUMMARY DATA
ELECTROMAGNETIC FIELD INTENSITIES AND FLUX DENSITIES (1)
UPLAND FLORA STUDIES

SITE NO.	MEAS PT	ELECTRIC FIELD IN THE AIR INTENSITY (V/m)		ELECTRIC FIELD IN THE EARTH INTENSITY (mV/m)		MAGNETIC FLUX DENSITY (mG)	
		ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz
4T1	1	35.--> ?	<0.001	400.->20.	0.31	20.-->1.0	<0.001
4T2	1	"	"	75.-->60.	0.24	20.-->5.0	"
4T2	2	"	"	"	0.25	"	"
4T3	1	"	0.001	100.->30.	0.16	"	"
4T3	2	"	<0.001	"	0.12	"	"
4C1	1	<0.001	"	0.2	0.27	0.001	0.011
4C1	2	"	"	"	0.56	"	0.18
4C1	3	"	"	"	0.004	"	0.002
4C1	4	"	"	"	0.16	"	0.009
4C1	5	"	"	"	0.38	"	0.005
4C2	1	"	"	"	0.011	"	0.001
4C2	2	"	"	"	0.006	"	"

1) Values shown are magnitudes determined as the square root of the sum of the squares of the orthogonal field components measured. Data listed for Estimated 76 Hz is based on theoretical analyses using the proposed location and operating conditions of the antenna elements along with the distance to each measurement point.

TABLE D-3

ELF ELECTROMAGNETIC FIELD EXPOSURE CRITERIA
FIELD INTENSITY RATIOS (1)
UPLAND FLORA STUDIES

COMPARED SITE NO.S	ELECTRIC FIELD IN THE AIR				ELECTRIC FIELD IN THE EARTH				MAGNETIC FIELD			
	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10
4T1/4C1-1	>35000.	>35000.	>35000.	1.0	>100.	>60.	>70.	1.1	>1000.	>1000.	>90.	0.1
4T1/4C1-2	"	"	"	"	"	"	>35.	0.6	"	"	>5.6 *	0.01 *
4T1/4C1-3	"	"	"	"	"	"	>5000.	78. *	"	"	>500.	0.5
4T1/4C1-4	"	"	"	"	"	"	>125.	1.9	"	"	>100.	0.1
4T1/4C1-5	"	"	"	"	"	"	>50.	0.8	"	"	>200.	0.2
4T1/4C2	"	"	"	"	"	"	>3000.	52.->28.*	"	"	>1000.	1.0
4T2/4C1-1	"	"	"	"	>300.	>240.	>210.	0.9	>5000.	>5000.	>450.	0.1
4T2/4C1-2	"	"	"	"	"	"	>100.	0.4	"	"	>28.	0.01 *
4T2/4C1-3	"	"	"	"	"	"	>15000.	61. *	"	"	>2500.	0.5
4T2/4C1-4	"	"	"	"	"	"	>370.	1.5	"	"	>550.	0.1
4T2/4C1-5	"	"	"	"	"	"	>150.	0.6	"	"	>1000.	0.2
4T2/4C2	"	"	"	"	"	"	>10000.	41.->22.*	"	"	>5000.	1.0
4T3/4C1-1	"	"	"	"	>150.	>180.	>100.	0.5	"	"	>450.	0.1
4T3/4C1-2	"	"	"	"	"	"	>50.	0.3	"	"	>28.	0.01 *
4T3/4C1-3	"	"	"	"	"	"	>7500.	35. *	"	"	>2500.	0.5
4T3/4C1-4	"	"	"	"	"	"	>180.	0.9	"	"	>550.	0.1
4T3/4C1-5	"	"	"	"	"	"	>75.	0.4	"	"	>1000.	0.2
4T3/4C2	"	"	"	"	"	"	>5000.	27.->11.*	"	"	>5000.	1.0

1) R1 = Test Site (76 Hz) / Control Site (76 Hz) R1 >= 10.
R2 = Test Site (76 Hz) / Test Site (60 Hz) R2 >= 10.
R3 = Test Site (76 Hz) / Control Site (60 Hz) R3 >= 10.
R4 = Test Site (60 Hz) / Control Site (60 Hz) 0.1 <= R4 <= 10.

* Does not meet the exposure criterion specification.

TABLE D-4

ELECTRIC FIELD INTENSITY IN AIR
UPLAND FLORA STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN AIR (1) (VOLTS/METER)			
		N-S	E-W	VERT	RSS
4T1	1	A	A	A	A
4T2	1	A	A	A	A
4T2	2	(2)	(2)	(2)	(2)
4T3	1	A	A	A	A
4T3	2	A	A	A	A
4C1	1	A	A	A	A
4C1	2	A	A	A	A
4C1	3	A	A	A	A
4C1	4	(2)	(2)	(2)	(2)
4C1	5	(2)	(2)	(2)	(2)
4C2	1	A	A	A	A
4C2	2	A	A	A	A

A) <0.001 volt/meter

1) N-S, E-W, and VERT are electric field intensities in air in the north-south, east-west, and vertical directions, respectively.
The composite magnitude of the electric field intensity in air is derived from the square root of the sum of the squares and is denoted by RSS.

2) Data not taken.

TABLE D-5

ELECTRIC FIELD INTENSITY IN EARTH
UPLAND FLORA STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN EARTH (1) (MILLIVOLTS/METER)		
		N-S	E-W	RSS
4T1	1	0.30	0.090	0.31
4T2	1	0.22	0.088	0.24
4T2	2	0.21	0.14	0.25
4T3	1	0.11	0.11	0.16
4T3	2	0.11	0.060	0.12
4C1	1	0.27	0.071	0.27
4C1	2	0.52	0.21	0.56
4C1	3	0.004	0.002	0.004
4C1	4	0.14	0.080	0.16
4C1	5	0.28	0.26	0.38
4C2	1	0.003	0.011	0.011
4C2	2	0.001	0.006	0.006

1) N-S and E-W are electric field intensities in earth in the north-south and east-west directions, respectively.
The composite magnitude of the electric field intensity in the earth is derived from the square root of the sum of the squares and is denoted as RSS.

TABLE D-6

MAGNETIC FLUX DENSITY
UPLAND FLORA STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz MAGNETIC FLUX DENSITY (1) (MILLIGAUSS)			
		N-S	E-W	VERT	RSS
4T1	1	A	A	A	A
4T2	1	A	A	A	A
4T2	2	A	A	A	A
4T3	1	A	A	A	A
4T3	2	A	A	A	A
4C1	1	0.002	0.003	0.011	0.011
4C1	2	0.059	0.051	0.16	0.18
4C1	3	0.001	A	A	0.001
4C1	4	A	0.002	0.009	0.009
4C1	5	A	A	0.005	0.005
4C2	1	A	A	0.001	0.001
4C2	2	A	A	0.001	0.001

A) <0.001 milligauss

1) N-S, E-W, and VERT are magnetic flux densities in the north-south, east-west, and vertical directions, respectively.
The composite magnitude of the magnetic flux density is derived from the square root of the sum of the squares and is denoted by RSS.

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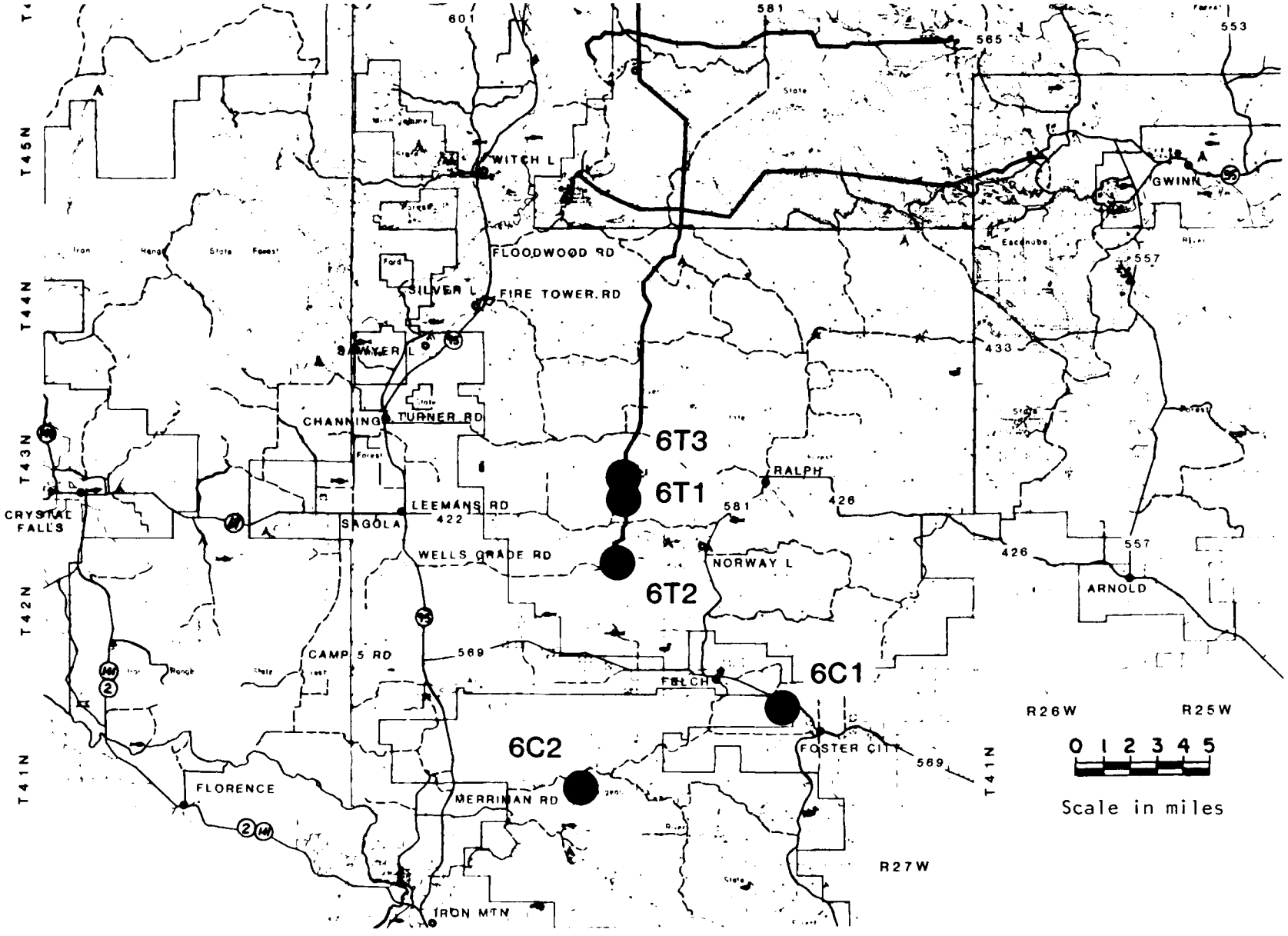

Figure F-1. Positions of test and control sites relative to transmitter facility antenna elements.

SOIL AMOEBAE STUDIES

On 9, 10, and 15 June and on 14 July 1983, IITRI field crews made ELF lectromagnetic field measurements at a total of five test and control sites or the soil amoebae study. The positions of these five sites relative to the roposed Republic Transmitter Facility antenna elements are shown on the omposite map in Figure F-1. The site numbers listed on the map are those sed by IITRI. Table F-1 provides a cross-reference of IITRI site numbers, nvestigator site names, and township, range, and section number locations for ach site.

TABLE F-1. SITE NO. CROSS-REFERENCE

IITRI Site No.	Investigator's Site Name	Location T	R	S
6T1	Leeman's Road Site - Old	T43N	R29W	26
6T2	Wells Grade Ant/Grd Site	T42N	R29W	10
6T3	Leeman's Road Site - New	T43N	R29W	23
6C1	Felch Control - C1	T41N	R28W	2
6C2	Merriman Truck Trail Control	T41N	R29W	21

The objectives for this study are to monitor population and species haracteristics, cell cycle, cropping efficiency, and distribution in the oil. The electric and magnetic fields in the earth are considered the most mportant electromagnetic factors to be examined. The electric field in the ir is not expected to have a significant impact on the objectives of this tudy.

Several of the above objectives require the use of a buried culture hamber at the study site. IITRI plans to characterize the relationship of nternal electromagnetic fields to those present in the environment.

Data listed for the magnitudes of the fields produced by the ELF system ere estimated at a frequency of 76 Hz (the expected operating frequency) and ased on calculations utilizing the proposed location and operating conditions

APPENDIX F
SOIL AMOEBAE STUDIES

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TABLE E-6

MAGNETIC FLUX DENSITY
AQUATIC ECOSYSTEM STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz MAGNETIC FLUX DENSITY (1) (MILLIGAUSS)			
		N-S	E-W	VERT	RSS
5T1	1	A	A	A	A
5T1	2	A	A	A	A
5C1	1	0.003	0.003	0.006	0.008
5C1	2	0.002	0.002	0.005	0.006
5C1	3	A	0.003	0.004	0.004
5C2	1	A	A	A	A
5C3	1	0.001	0.001	0.003	0.003
5C4	1	A	0.001	0.001	0.002
5C5	1	0.001	A	A	0.002
5C6	1	0.001	A	0.006	0.006
5C10	1	A	A	A	A
5C11	1	A	A	A	A
5C12	1	A	A	A	A
5C13	1	A	A	A	A

A) <0.001 milligauss

1) N-S, E-W, and VERT are magnetic flux densities in the north-south, east-west, and vertical directions, respectively. The composite magnitude of the magnetic flux density is derived from the square root of the sum of the squares and is denoted by RSS.

TABLE E-5

ELECTRIC FIELD INTENSITY IN EARTH
AQUATIC ECOSYSTEM STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN EARTH (1) (MILLIVOLTS/METER)		
		N-S	E-W	RSS
5T1	1	0.23	0.30	0.38
5T1	2	0.12	0.14	0.18
5C1	1	1.7	0.32	1.7
5C1	2	1.0	1.5	1.8
5C1	3	1.3	0.36	1.3
5C2	1	0.001	0.001	0.001
5C3	1	0.036	0.033	0.049
5C4	1	0.074	0.040	0.084
5C5	1	0.075	0.011	0.076
5C6	1	0.28	0.94	0.98
5C10	1	0.12	0.074	0.14
5C11	1	0.25	0.11	0.27
5C12	1	0.21	0.058	0.22
5C13	1	0.14	0.056	0.15

1) N-S and E-W are electric field intensities in earth in the north-south and east-west directions, respectively.
The composite magnitude of the electric field intensity in the earth is derived from the square root of the sum of the squares and is denoted as RSS.

TABLE E-4

ELECTRIC FIELD INTENSITY IN AIR
AQUATIC ECOSYSTEM STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN AIR (1) (VOLTS/METER)			
		N-S	E-W	VERT	RSS
5T1	1	A	A	A	A
5T1	2	A	A	A	A
5C1	1	0.002	A	A	0.002
5C1	2	A	A	A	A
5C1	3	A	A	A	A
5C2	1	A	A	A	A
5C3	1	A	A	0.002	0.002
5C4	1	A	A	A	A
5C5	1	A	A	A	A
5C6	1	A	0.003	A	0.003
5C10	1	B	B	B	B
5C11	1	B	B	B	B
5C12	1	B	B	B	B
5C13	1	B	B	B	B

A) <0.001 volt/meter

B) <0.13 Volt/meter; high sensitivity range (See Note A) of the electric field probe was not functioning for these measurements.

1) N-S, E-W, and VERT are electric field intensities in air in the north-south, east-west, and vertical directions, respectively.
The composite magnitude of the electric field intensity in air is derived from the square root of the sum of the squares and is denoted by RSS.

TABLE E-3

ELF ELECTROMAGNETIC FIELD EXPOSURE CRITERIA
FIELD INTENSITY RATIOS (1)
AQUATIC ECOSYSTEMS STUDY

COMPARED SITE NO.S	ELECTRIC FIELD IN THE AIR				ELECTRIC FIELD IN THE EARTH				MAGNETIC FIELD			
	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10
5T1/5C1	>1000.	>1000.	>500.	1.—>0.5	6.3 *	>130.	>27.	0.3—>0.1	>30.	>1500.	>180.	0.3—>0.1
5T1/5C2	"	"	>1000.	1.0	8.3 *	"	50000.	>180. *	"	"	>1500.	1.0
5T1/5C3	"	"	>500.	0.5	6.3 *	"	1020.	7.8—>3.7	"	"	>500.	0.3
5T1/5C4	"	"	>1000.	1.0	3.8 *	"	595.	4.5—>2.1	>15.	"	>750.	0.5
5T1/5C5	>100.	"	"	"	3.3 *	"	660.	5.0—>2.4	"	"	"	"
5T1/5C6	>1000.	"	>300.	0.3	5.0 *	"	51.	0.4—>0.2	>30.	"	>250.	0.2
5T1/5C10	"	"	A	A	6.3 *	"	360.	2.7—>1.3	"	"	>1500.	1.0
5T1/5C11	"	"	A	A	5.0 *	"	185.	1.4—>0.7	"	"	"	"
5T1/5C12	"	"	A	A	3.3 *	"	230.	1.7—>0.8	"	"	"	"
5T1/5C13	"	"	A	A	6.3 *	"	330.	2.5—>1.2	"	"	"	"

A) Data insufficient for comparison.

1) R1 = Test Site (76 Hz) / Control Site (76 Hz) R1 >= 10.
R2 = Test Site (76 Hz) / Test Site (60 Hz) R2 >= 10.
R3 = Test Site (76 Hz) / Control Site (60 Hz) R3 >= 10.
R4 = Test Site (60 Hz) / Control Site (60 Hz) 0.1 <= R4 <= 10.

* Does not meet the exposure criterion specification.

TABLE E-2

SUMMARY DATA
ELECTROMAGNETIC FIELD INTENSITIES AND FLUX DENSITIES (1)
AQUATIC ECOSYSTEMS STUDY

SITE NO.	MEAS PT	ELECTRIC FIELD IN THE AIR INTENSITY (V/m)		ELECTRIC FIELD IN THE EARTH INTENSITY (mV/m)		MAGNETIC FLUX DENSITY (mG)	
		ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz
5T1	1	1.0 --> ?	<0.001	50.	0.38	1.5	<0.001
5T1	2	"	"	"	0.18	3.0	"
5C1	1	<0.001	0.002	8.0	1.7	0.05	0.008
5C1	2	"	<0.001	"	1.8	"	0.006
5C1	3	"	"	"	1.3	"	0.004
5C2	1	"	"	6.0	0.001	"	<0.001
5C3	1	"	0.002	8.0	0.049	"	0.003
5C4	1	"	<0.001	13.	0.084	0.1	0.002
5C5	1	<0.01	"	15.	0.076	"	"
5C6	1	<0.001	0.003	10.	0.98	0.05	0.006
5C10	1	"	<0.13	8.0	0.14	"	<0.001
5C11	1	"	"	10.	0.27	"	"
5C12	1	"	"	15.	0.22	"	"
5C13	1	"	"	8.0	0.15	"	"

1) Values shown are magnitudes determined as the square root of the sum of the squares of the orthogonal field components measured. Data listed for Estimated 76 Hz is based on theoretical analyses using the proposed location and operating conditions of the antenna elements along with the distance to each measurement point.

levels. Relocation of test site 5T1 would not correct this problem, and it is concluded that test/control site pair 5T1/5C2 is unacceptable.

In summary, no test/control site pair meets the exposure criteria. If test site 5T1 were moved to directly under the antenna element, the pairing of test site 5T1 with control site 5C1 would satisfy all of the exposure criteria. If test site 5T1 is left unchanged, the selection of one or more new control sites as indicated above would satisfy the Test(76)/Control(76) criteria. If no new control sites can be chosen and test site 5T1 is left unchanged, then the test/control site pairing of site 5T1 with site 5C1 or 5C3 is conditionally acceptable and the pairing of site 5T1 with any of the sites 5C2, 5C4, 5C5, or 5C6, is unacceptable.

Data listed for the magnitudes of the fields produced by the ELF system were estimated at a frequency of 76 Hz (the expected operating frequency) and based on calculations utilizing the proposed location and operating conditions of the Republic Transmitter Facility antenna elements and the distance to each measurement point. A summary of the measured 60 Hz and estimated 76 Hz data taken at measurement points for each of the sites is given in Table E-2. These summarized data were compiled from the detailed data found in Tables E-4, E-5, and E-6. Data have been presented for the control sites 5C10, 5C11, 5C12, and 5C13, for the sake of completeness. It is understood that these sites were not considered as current control sites for the aquatic ecosystems study. The site numbers assigned to these control sites reflect this fact allowing the addition of control sites under current consideration to be assigned numbers in sequence following control site 5C6.

The ELF electromagnetic field exposure criteria were applied to the data by computing the field intensity ratios utilized in the mathematical representation of the exposure criteria. The results of this effort are illustrated in Table E-3.

Review of the ratios presented in Table E-3 indicates that no test/control site pair satisfies all of the exposure criteria. The ratio Test(76)/Control(76) for the electric field in the earth for all test/control site pairs fails to meet the exposure criteria requirement of being greater than or equal to ten. This failure to meet the exposure criteria is a result of the location of test site 5T1 relative to the ELF antenna element and the location of the control sites relative to the test site. However, relocation of the test site to a point directly under the antenna element would change the values of the electric field in the earth for R1. (Values for test/control site pairs 5T1/5C1, 5T1/5C2, and 5T1/5C5 would then be 11, 14, and 5.7, respectively). Alternatively, if test site 5T1 is left unchanged and a control site is repositioned on the Ford River, the resulting location of the control site necessary to meet the Test(76)/Control(76) criteria would be T43N:R28W:S22 (east of site 5C1, near Ralph) or T43N:R30W, at the boundary of sections 13 and 14 (west of Site 5C2).

Table E-3 also indicates that the ratio R4 for test/control site pair 5T1/5C2 fails to meet the exposure criteria based on measured 60 Hz field

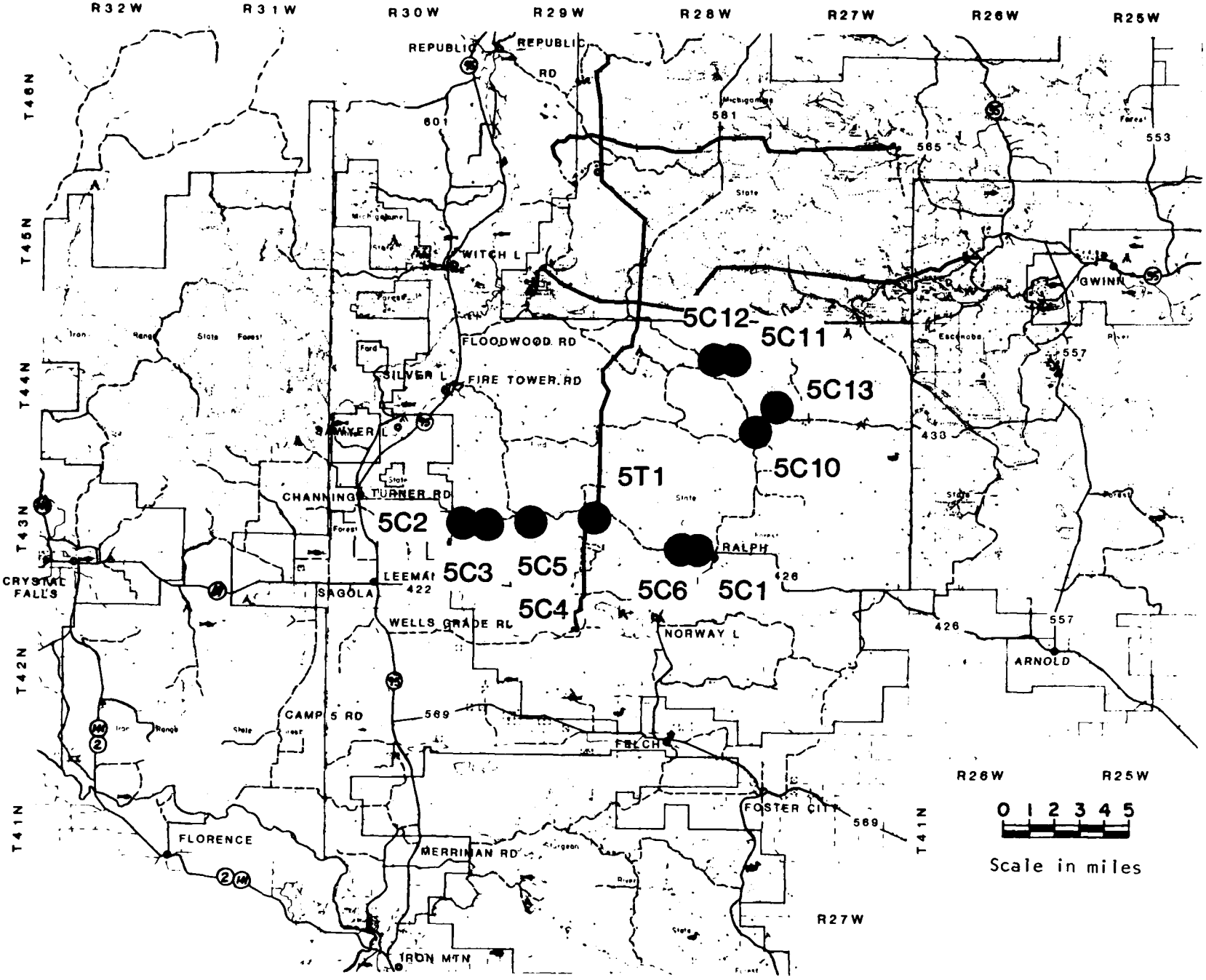

Figure E-1. Positions of test and control sites relative to transmitter facility antenna elements.

AQUATIC ECOSYSTEMS STUDIES

On 13 and 16 June 1983, IITRI field crews made ELF electromagnetic field measurements at a total of eleven test and control sites for the aquatic ecosystems study. The positions of these eleven sites relative to the proposed Republic Transmitter Facility antenna elements are shown on the composite map in Figure E-1. The site numbers listed on the map are those used by IITRI. Table E-1 provides a cross-reference of IITRI site numbers, investigator site names, and township, range, and section number locations for each site.

TABLE E-1. SITE NO. CROSS-REFERENCE

IITRI Site No.	Investigator's Site Name	Location T	R	S
5T1	Ford Experimental Site (FEX)	T43N	R29W	11
5C1	Ford Control Downstream (FCD)	T43N	R28W	21
5C2	Ford Control Upstream 2 (FCU2)	T43N	R30W	13
5C3	Ford Control Upstream (FCU)	T43N	R29W	18
5C4	Ramshackle	T43N	R29W	16/17
5C5	Ford Site 1 (FS1)	T43N	R29W	16
5C6	Ford Site 2 (FS2)	T43N	R28W	20
5C10	McGregor Cr. Experimental Site	T44N	R28W	25
5C11	Flat Rock Club Exp. Site	T44N	R28W	11
5C12	Schwartz Cr. Experimental Site	T44N	R28W	10
5C13	West Branch Campground 2 Exp.	T44N	R27W	19

The approach of the aquatic ecosystems study is to integrate the major interrelated and interactive components of aquatic ecosystems (periphytic algae, aquatic insects, and fish) and to monitor events and processes critical to stream ecosystems. The electric field in the earth near the surface and the magnetic field are considered the most important factors influencing the aquatic ecosystems study. The electric field in the air is expected to have no impact on the components of this study.

APPENDIX E
AQUATIC ECOSYSTEMS STUDIES

of the Republic Transmitter Facility antenna elements and the distance to each measurement point. A summary of the measured 60 Hz and estimated 76 Hz data taken at measurement points for each of the sites is given in Table F-2. These summarized data were compiled from the detailed data found in Tables F-4, F-5 and F-6.

The ELF electromagnetic field exposure criteria were applied to the data by computing the field intensity ratios utilized in the mathematical representation of the exposure criteria. The results of this effort are illustrated in Table F-3.

Review of the ratios presented in Table F-3 indicates that test/control site pairs 6T2/6C2 and 6T3/6C2 will satisfy the exposure critria. The pairing of test sites 6T1, 6T2, or 6T3 with control site 6C1 fails to meet the exposure criteria specification that the ratio R4, for the electric field in the earth, be greater than or equal to one tenth. This failure is due to the high level of 60 Hz electric field intensity measured at control site 6C1. Control site 6C1 is located relatively close to the Felch power substation and a high voltage power transmission line. The site pairing of 6T1 with 6C2 also fails to meet the exposure criteria specification of ratio R4 for the electric field in the earth. The measured 60 Hz electric field intensity at test site 6T1 is significantly lower than that at control site 6C2. Test site 6T1 is more remote from any potential 60 Hz voltage sources than either control site 6C2 or test site 6T2.

In summary, the test/control site pairing of site 6T2 or 6T3 with site 6C2 is acceptable; the pairing of site 6T1, 6T2, or 6T3 with site 6C1 and the pairing of test site 6T1 with control site 6C2 are unacceptable.

TABLE F-2

SUMMARY DATA
ELECTROMAGNETIC FIELD INTENSITIES AND FLUX DENSITIES (1)
SOIL AMOEBAE STUDY

SITE NO.	MEAS PT	ELECTRIC FIELD IN THE AIR INTENSITY (V/m)		ELECTRIC FIELD IN THE EARTH INTENSITY (mV/m)		MAGNETIC FLUX DENSITY (mG)	
		ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz	ESTIMATED 76 Hz	MEASURED 60 Hz
6T1	1	15.--> ?	<0.001	65.	0.017	10.	0.003
6T2	1	"	"	"	0.28	"	<0.001
6T3	1	"	"	"	0.087	"	0.001
6C1	1	<0.001	A	1.0	3.8	0.02	0.004
6C2	1	"	<0.001	0.5	0.32	"	0.004

A) Measurement data not taken.

1) Values shown are magnitudes determined as the square root of the sum of the squares of the orthogonal field components measured. Data listed for Estimated 76 Hz is based on theoretical analyses using the proposed location and operating conditions of the antenna elements along with the distance to each measurement point.

TABLE F-3

ELF ELECTROMAGNETIC FIELD EXPOSURE CRITERIA
FIELD INTENSITY RATIOS (1)
SOIL AMOEBAE STUDY

COMPARED SITE NO.S	ELECTRIC FIELD IN THE AIR				ELECTRIC FIELD IN THE EARTH				MAGNETIC FIELD			
	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10
6T1/6C1	>15000.	>15000.	A	A	65.	>3800.	17.	0.004 *	500.	>3000.	2500.	0.75
6T1/6C2	"	"	>15000.	1.0	130.	"	200.	0.05 *	"	"	"	"
6T2/6C1	"	"	A	A	65.	>230.	17.	0.07 *	"	>10000.	"	0.25
6T2/6C2	"	"	>15000.	1.0	130.	"	200.	0.9	"	"	"	"
6T3/6C1	"	"	A	A	65.	>740.	17.	0.02 *	"	"	"	"
6T3/6C2	"	"	>15000.	1.0	130.	"	200.	0.3	"	"	"	"

A) Data insufficient for comparison.

1) R1 = Test Site (76 Hz) / Control Site (76 Hz) R1 >= 10.
R2 = Test Site (76 Hz) / Test Site (60 Hz) R2 >= 10.
R3 = Test Site (76 Hz) / Control Site (60 Hz) R3 >= 10.
R4 = Test Site (60 Hz) / Control Site (60 Hz) 0.1 <= R4 <= 10.

* Does not meet the exposure criterion specification.

TABLE F-4

ELECTRIC FIELD INTENSITY IN AIR
SOIL AMOEBAE STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN AIR (1) (VOLTS/METER)			
		N-S	E-W	VERT	RSS
6T1	1	(2)	(2)	(2)	(2)
6T2	1	A	A	A	A
6T3	1	A	A	A	A
6C1	1	(2)	(2)	(2)	(2)
6C2	1	A	A	A	A

A) <0.001 volt/meter

1) N-S, E-W, and VERT are electric field intensities in air in the north-south, east-west, and vertical directions, respectively.
The composite magnitude of the electric field intensity in air is derived from the square root of the sum of the squares and is denoted by RSS.

2) Data not taken.

TABLE F-5

ELECTRIC FIELD INTENSITY IN EARTH
SOIL AMOEBAE STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz ELECTRIC FIELD INTENSITY IN EARTH (1) (MILLIVOLTS/METER)		
		N-S	E-W	RSS
6T1	1	0.006	0.017	0.017
6T2	1	0.13	0.26	0.28
6T3	1	0.074	0.046	0.087
6C1	1	1.7	3.4	3.8
6C2	1	0.11	0.30	0.32

1) N-S and E-W are electric field intensities in earth in the north-south and east-west directions, respectively.
The composite magnitude of the electric field intensity in the earth is derived from the square root of the sum of the squares and is denoted as RSS.

TABLE F-6

MAGNETIC FLUX DENSITY
SOIL AMOEBAE STUDY SITES

SITE NO	MEAS PT	AMBIENT 60 Hz MAGNETIC FLUX DENSITY (1) (MILLIGAUSS)			
		N-S	E-W	VERT	RSS
6T1	1	0.003	A	A	0.003
6T2	1	A	A	A	A
6T3	1	A	A	0.001	0.001
6C1	1	0.003	0.002	0.002	0.004
6C2	1	0.003	A	0.001	0.004

A) <0.001 milligauss

1) N-S, E-W, and VERT are magnetic flux densities in the north-south, east-west, and vertical directions, respectively.
The composite magnitude of the magnetic flux density is derived from the square root of the sum of the squares and is denoted by RSS.

APPENDIX G
SLIME MOLD STUDIES

SLIME MOLD STUDIES

On 28 and 29 April 1983, IITRI field crews made ELF electromagnetic field measurements at a total of four test and control sites for the slime mold (Physarum polycephalum) study. A cumulative total of six test and control sites has been identified for the slime mold study since the fall of 1982. Of the four sites measured in 1983, three sites (7A1, 7C1, and 7C2) had previously been documented from measurements made in the fall of 1982, and were reported in IITRI Technical Report E06516-4.[1] The positions of all six sites relative to the Clam Lake (Wis.) Transmitter Facility antenna elements are shown on the composite map in Figure G-1. The site numbers listed on the map are those used by IITRI. Table G-1 provides a cross-reference of IITRI site numbers, investigator site names, and township, range, and section number locations for each site.

TABLE G-1. SITE NO. CROSS-REFERENCE

IITRI Site No.	Investigator's Site Name	Location T	R	S
7A1	Antenna No. 1	T43N	R4W	33
7G1	Ground No. 1	T43N	R4W	23
7G2	Ground No. 2	T42N	R5W	6
7G3	Ground No. 3	T42N	R5W	7
7C1	Control No. 1	T43N	R2W	31
7C2	Control No. 2	T44N	R5W	31

The slime mold study has been designed to monitor for ELF electromagnetic field exposure effects on the respiration and mitosis of the slime mold, Physarum polycephalum. The electric and magnetic fields in the earth are considered important electromagnetic factors influencing soil biota. The electric field in the air is not expected to have a significant impact on the objectives of this study.

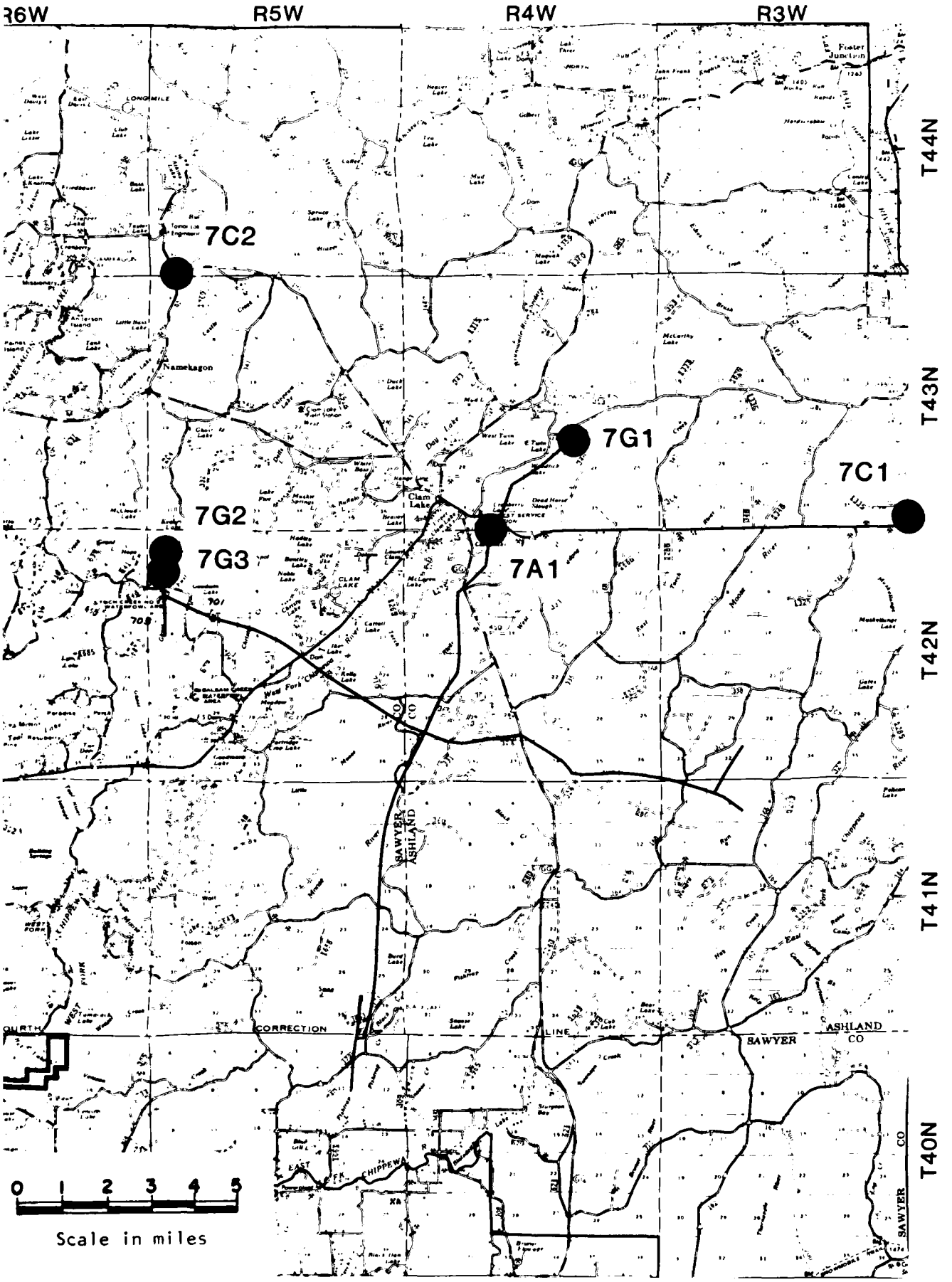

Figure G-1. Positions of test and control sites relative to transmitter facility antenna elements.

The use of a buried culture chamber in the field portion of this study requires that special consideration be taken in specifying the culture's ELF electromagnetic field exposure. The electromagnetic field intensities reported below, as well as those reported in IITRI Technical Report E06516-4, are of the undisturbed fields present at each of the study sites and do not address the actual electromagnetic field exposure of the biota in culture.

Data listed for the magnitudes of the fields produced by the ELF system were determined as the square root of the sum of the squares of the orthogonal field components measured. Data for 76 Hz represent values determined by summation of the magnitudes of the fields produced by the east-west and north-south antennas extrapolated to full operating current (300 amperes). A summary of the measured 60 Hz and 76 Hz data taken at measurement points for each of the sites is given in Table G-2. These summarized data were compiled from the detailed data found in Tables G-4 and G-5.

The field data measured in 1983 match well with the 1982 data presented in IITRI Technical Report E06516-4. Direct comparison of sites 7A1, 7C1, and 7C2 found in Table G-2 of this report with Table 1 of IITRI Technical Report E06516-4 indicates very little change in the field data between 1982 and 1983. This was expected of the 76 Hz data and was anticipated for the 60 Hz data, since the 60 Hz power loading in the immediate area has not changed over the past year.

The ELF electromagnetic field exposure criteria were applied to the data by computing the field intensity ratios utilized in the mathematical representation of the exposure criteria. The results of this effort are illustrated in Table G-3. Only four sites were measured in 1983 based on conversations with the investigators in the field and information presented in the University of Wisconsin-Parkside report on the effects of exposing the slime mold Physarum polycephalum to electromagnetic fields, which is included in IITRI Technical Report E06516-5.[3] Site 7G3, selected in 1983, was found to be biologically suitable for the purposes of this study and easily accessible.

Review of the ratios presented in Table G-3 indicates that only the pairing of test site 7G3 with control site 7C1 will completely satisfy the exposure criteria. The pairing of test site 7A1 with either of the control sites 7C1 or 7C2 is conditionally acceptable. The pairing of test site 7A1

ith control site 7C1 fails to satisfy the exposure criteria specification for he ratio R4 for the magnetic flux density. The measured 60 Hz value at test ite 7A1 with control site 7C2 fails to satisfy the exposure criteria pecification for the ratio R4 for the electric field intensity in the arth. The measured 60 Hz value at control site 7C2 is more than 11 times igher than that at test site 7A1. The pairing of test site 7G3 with control ite 7C2 fails to satisfy the exposure criteria specification for the ratio R4 or both the electric field intensity in the earth and the magnetic flux lensity.

In summary, the test/control site pairing of site 7G3 with site 7C1 is cceptable; the pairing of site 7A1 with either site 7C1 or 7C2 is condition-lly acceptable; and the pairing of site 7G3 with site 7C2 is unacceptable.

TABLE G-2

SUMMARY DATA
ELECTROMAGNETIC FIELD INTENSITIES AND FLUX DENSITIES (1)
SLIME MOLD STUDY

SITE NO.	MEAS PT	ELECTRIC FIELD IN THE AIR INTENSITY (V/m)		ELECTRIC FIELD IN THE EARTH INTENSITY (V/m)		MAGNETIC FLUX DENSITY (Gauss)	
		76 Hz	60 Hz	76 Hz	60 Hz	76 Hz	60 Hz
7A1	1	A	A	0.17	0.00013	0.15	0.000019
7G3	1	"	"	1.9	0.000091	0.0053	0.000001
7C1	1	"	"	0.0019	0.000070	0.000025	<0.000001
7C2	1	"	"	0.0014	0.0015	0.000019	0.000047

A) Data not taken

1) Values shown are magnitudes determined as the square root of the sum of the squares of the orthogonal field components measured. Data for 76 Hz represent worst case values determined by summation of the magnitudes of the fields produced by the E-W and N-S antennas extrapolated to full operating current (300 Amps).

TABLE G-3

ELF ELECTROMAGNETIC FIELD EXPOSURE CRITERIA
FIELD INTENSITY RATIOS (1)
SLIME MOLD STUDY

COMPARED SITE NO.S	ELECTRIC FIELD IN THE AIR				ELECTRIC FIELD IN THE EARTH				MAGNETIC FIELD			
	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10
7A1/7C1	A	A	A	A	89.	1300.	2400.	1.9	6000.	7900.	>150000.	>19. *
7A1/7C2	"	"	"	"	121.	"	110.	0.09 *	7900.	150000.	3200.	0.4
7G3/7C1	"	"	"	"	1000.	21000.	27000.	1.3	210.	280.	>5300.	1.0
7G3/7C2	"	"	"	"	1350.	"	1300.	0.06 *	280.	5300.	110.	0.02 *

1) R1 = Test Site (76 Hz) / Control Site (76 Hz) R1 >= 10.
R2 = Test Site (76 Hz) / Test Site (60 Hz) R2 >= 10.
R3 = Test Site (76 Hz) / Control Site (60 Hz) R3 >= 10.
R4 = Test Site (60 Hz) / Control Site (60 Hz) 0.1 <= R4 <= 10.

* Does not meet the exposure criterion specification.

TABLE G-4

MAGNETIC FLUX DENSITY
SLIME MOLD STUDY SITES

SITE NO	MEAS PT	MAGNETIC FLUX DENSITY (1) (GAUSS)											
		N/S ANTENNA [Freq=76 Hz CW; I=300 A]				E/W ANTENNA [Freq=76 Hz CW; I=300 A]				AMBIENT 60 Hz			
		N-S	E-W	VERT	RSS	N-S	E-W	VERT	RSS	N-S	E-W	VERT	RSS
7A1	1	0.14	0.0032	0.046	0.14	0.0044	0.00016	0.0015	0.0046	0.000018	<0.000001	0.000006	0.000019
7G3	1	0.000056	0.000022	<0.000001	0.000060	0.0050	0.000084	0.0014	0.0052	0.000001	0.000001	<0.000001	0.000001
7C1	1	0.000005	0.000010	0.000004	0.000012	0.000006	0.000010	0.000005	0.000013	<0.000001	<0.000001	<0.000001	<0.000001
7C2	1	0.000003	0.000007	0.000005	0.000009	0.000004	0.000006	0.000006	0.000010	0.000045	0.000010	0.000003	0.000047

1) N-S, E-W, VERT are magnetic flux densities in the north-south, east-west, and vertical directions, respectively. For sites 7A1 and 7G3, N-S and E-W correspond to flux densities in the parallel and perpendicular directions to the antenna element, respectively. For site 7C1, N-S and E-W correspond to flux densities along a line 45 degrees rotated cw from the north-south and east-west directions, respectively. Each orthogonal data component has been extrapolated to full antenna operating current, as indicated by I = 300 Amps.
The composite magnitude of the magnetic flux density is derived from the square root of the sum of the squares and is denoted by RSS.

AD-A153 120 ELF (EXTREMELY LOW FREQUENCY) COMMUNICATIONS SYSTEM ECOLOGICAL MONITORING..(U) IIT RESEARCH INST CHICAGO IL J O ENK ET AL. JAN 85 IITRI-E06549-10 N00039-84-C-0070 2/2

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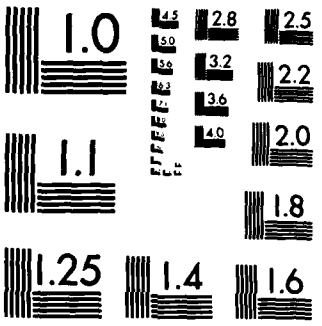

TABLE G-5

ELECTRIC FIELD INTENSITY IN EARTH
SLIME MOLD STUDY SITES

SITE NO	MEAS PT	ELECTRIC FIELD INTENSITY IN EARTH (1) (VOLTS/METER)								
		N/S ANTENNA [Freq=76 Hz CW; I=300 A]			E/W ANTENNA [Freq=76 Hz CW; I=300 A]			AMBIENT 60 Hz		
		N-S	E-W	RSS	N-S	E-W	RSS	N-S	E-W	RSS
7A1	1	0.16	0.018	0.16	0.0066	0.0030	0.0073	0.00013	0.000033	0.00013
7G3	1	0.0011	0.018	0.018	0.12	1.9	1.9	0.000016	0.000090	0.000091
7C1	1	0.00068	0.00068	0.00096	0.00050	0.00082	0.00096	0.000061	0.000035	0.000070
7C2	1	0.00032	0.00074	0.00081	0.00032	0.00046	0.00056	0.0010	0.0011	0.0015

1) N-S and E-W are electric field intensities in earth in the north-south and east-west directions, respectively. For sites 7A1 and 7G3, N-S and E-W correspond to field intensities in the parallel and perpendicular directions to the antenna element, respectively. For site 7C1, N-S and E-W correspond to field intensities along a line 45 degrees rotated cw from the north-south and east-west directions, respectively. Each orthogonal data component has been extrapolated to full antenna operating current, as indicated by I = 300 Amps.
The composite magnitude of the electric field intensity in earth is deived from the square root of the sum of the squares and is denoted by RSS.

APPENDIX H
WETLANDS STUDIES

WETLANDS STUDIES

On 27 through 30 June 1983; on 11, 12, and 19 through 21 July 1983; and on 9 and 10 August 1983, IITRI field crews made ELF electromagnetic field measurements at a total of 15 test, control, and intermediate sites for the wetlands study. The positions of these 15 sites relative to the Clam Lake (Wis.) Transmitter Facility antenna elements are shown on the composite map in Figure H-1. The site numbers listed on the map are those used by IITRI. Table H-1 provides a cross-reference of IITRI site numbers, investigator site names, and township, range, and section number locations for each site.

TABLE H-1. SITE NO. CROSS-REFERENCE

IITRI Site No.	Investigator's Site Name	Location T	R	S
8A1	UW Site 21 Antenna	T41N	R5W	1
8A2	UW Site 22 Antenna	T42N	R5W	36
8A3	UW Site 40 Antenna	T42N	R5W	17
8G1	UW Site 10 Ground	T43N	R4W	22
8G2	UW Site 10 Ground	T43N	R4W	22
8C1	UW Site 19 Control	T40N	R3W	15
8C2	UW Site 20 Control	T40N	R3W	10
8C3	UW Site 41 Control	T40N	R3W	2
8M1	UW Site 9 Intermediate	T41N	R5W	15
8M2	UW Site 2 Intermediate	T41N	R4W	19
8M3	UW Site 7 Intermediate	T41N	R4W	33
8M4	UW Site 11 Intermediate	T43N	R4W	36
8M5	UW Site 1 Intermediate	T41N	R4W	20
8M6	UW Site 15 Intermediate	T42N	R4W	28
8M7	UW Site 14 Intermediate	T41N	R4W	14

The wetlands study will examine the competitive ability of three types of wetland plants (herbs, shrubs, and trees) by examining the organismal characteristics of leaf diffusion and cation transport. The functional

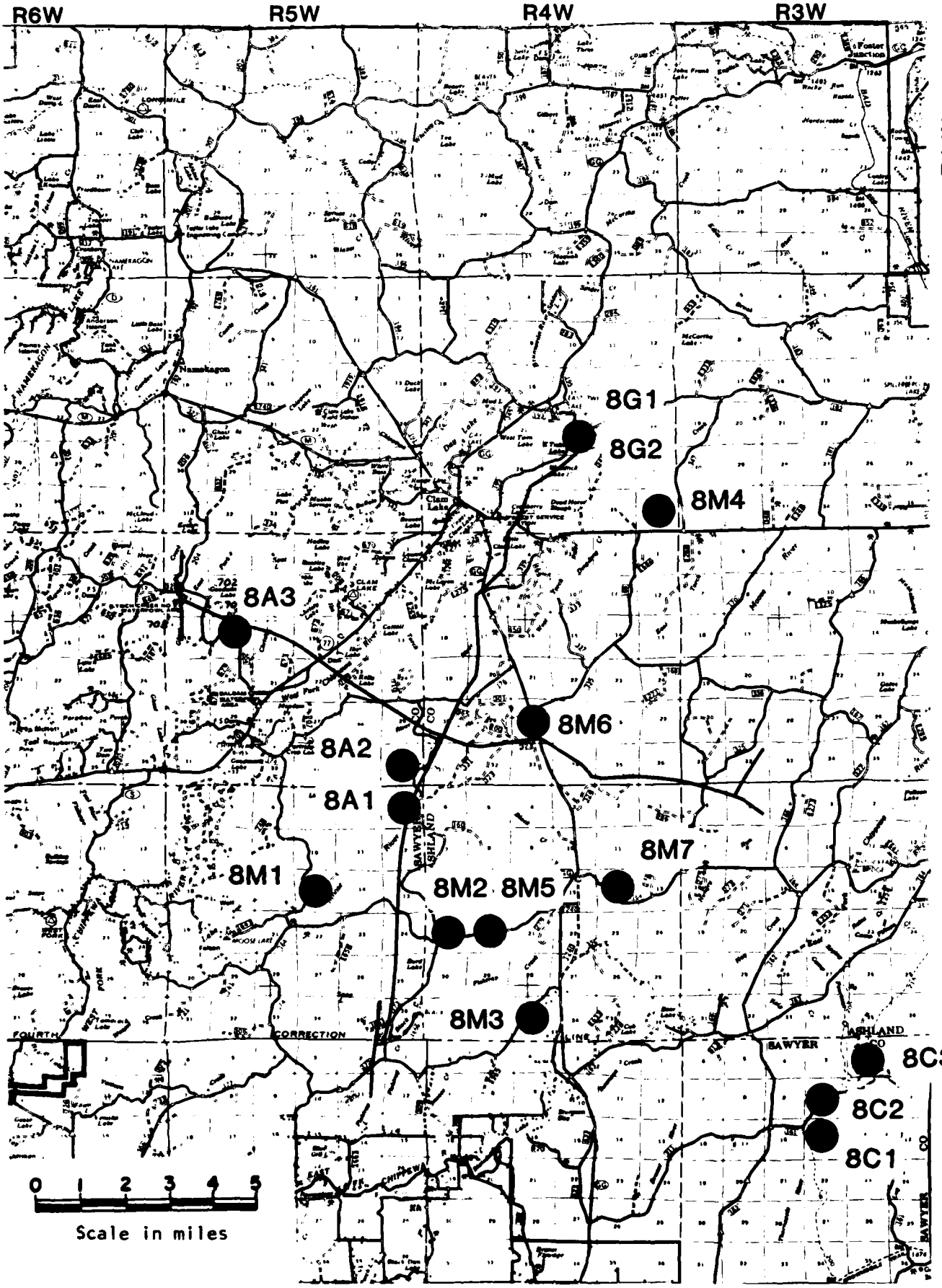

Figure H-1. Positions of test, control, and intermediate sites relative to transmitter facility antenna elements.

operation of the decomposer community will also be assessed by studying the decomposition rate of standardized cellulose material. The electric and magnetic fields in the earth are considered important electromagnetic factors influencing wetlands biota and processes. The electric and magnetic fields in the air can influence any object extending above the surface. Since the electric field in the air can be effectively shunted by trees or plants on the perimeter of a given study plot, special care was taken in specifying the electric field intensity across the plot. The specific design of the study plots (long and narrow) and their orientation (parallel to the antenna) diminish the need for field gradient measurements across the width (4 m) of the study plots. However, data were taken at measurement points along the length (60 m) of the plots.

Data listed for the magnitudes of the fields produced by the ELF system were determined as the square root of the sum of the squares of the orthogonal field components measured. Data for 76 Hz represent worst case values determined by summation of the magnitudes of the fields produced by the east-west and north-south antennas extrapolated to full operating current (300 amperes). A summary of the measured 60 Hz and 76 Hz data taken at measurement points for each of the sites is given in Table H-2. These summarized data were compiled from the detailed data found in Tables H-4, H-5, and H-6.

The ELF electromagnetic field exposure criteria were applied to the data by computing the field intensity ratios utilized in the mathematical representation of the exposure criteria. The results of this effort are illustrated in Table H-3. Sites 8G1 and 8G2 were included as test sites for the purpose of evaluating them with regard to exposure criteria acceptability. Based on conversations with the investigators, the field intensity data for all of the intermediate sites (8M1 thru 8M7) recorded in 1983 have been presented in Table H-2, but these sites are not being considered as test sites; instead, the wetlands study will use these sites as part of a field gradient study design.

Review of the ratios presented in Table H-3 indicates that any pairing of test sites 8A1, 8A2, 8A3, or 8G2 with control sites 8C1, 8C2, or 8C3, or the pairing of test site 8G1 with control sites 8C1 or 8C3 will satisfy the exposure criteria. The pairing of test site 8G1 with control site 8C2 is

marginally out of specification for the ratio R4 of the exposure criteria for the electric field in the earth. This is due to the relatively higher values recorded for 60 Hz electric field intensity at test site 8G1 in terms of the rest of the test site measured.

In summary, the test/control site pairings of sites 8A1 8A2, 8A3, or 8G2 with sites 8C1, 8C2, or 8C3, or the pairing of site 8G1 with either site 8C1 or 8C3 are acceptable, and the pairing of site 8G1 with site 8C2 is conditionally acceptable.

TABLE H-2

SUMMARY DATA
ELECTROMAGNETIC FIELD INTENSITIES AND FLUX DENSITIES (1)
WETLANDS STUDY

(Page one of two pages)

SITE NO.	MEAS PT	ELECTRIC FIELD IN THE AIR INTENSITY (V/m)		ELECTRIC FIELD IN THE EARTH INTENSITY (V/m)		MAGNETIC FLUX DENSITY (Gauss)	
		76 Hz	60 Hz	76 Hz	60 Hz	76 Hz	60 Hz
8A1	1	0.12	<0.001	0.082	0.000023	0.022	<0.000001
8A1	2	0.18	"	0.087	0.000020	0.024	0.000005
8A2	1	0.19	"	0.15	0.000081	0.0080	0.000002
8A2	2	0.15	"	0.093	0.000044	0.0076	<0.000001
8A2	3	0.12	"	0.049	0.000028	0.0081	0.000002
8A3	1	0.21	"	0.24	0.000065	0.022	0.000001
8A3	2	0.25	"	0.25	0.000072	0.021	"
8A3	3	0.29	"	0.26	0.000070	0.023	"
8G1	1	0.62	"	0.45	0.00036	0.0024	0.000002
8G1	2	0.51	"	0.51	0.00041	"	"
8G1	3	0.47	"	0.43	0.00035	0.0023	"
8G2	1	0.31	"	0.29	0.00030	0.00067	<0.000001
8G2	2	0.33	"	0.32	0.00035	0.00072	"
8G2	3	0.27	"	0.24	0.00028	0.00070	"
8C1	1	<0.001	"	0.0018	0.000036	0.000025	"
8C1	2	"	"	0.0020	0.000086	"	"
8C2	1	"	"	0.0012	0.000026	0.000024	"
8C2	2	"	"	0.0013	0.000034	0.000023	"
8C3	1	"	"	0.0027	0.000075	0.000025	"
8C3	2	"	"	"	0.000077	"	"
8C3	3	"	"	0.0029	0.000081	"	"
8M1	1	0.039	"	0.031	0.000091	0.00022	"
8M1	2	0.034	"	0.032	0.000094	"	"
8M1	3	0.024	"	0.028	0.000077	"	"

A) Data not taken

1) Values shown are magnitudes determined as the square root of the sum of the squares of the orthogonal field components measured. Data for 76 Hz represent worst case values determined by summation of the magnitudes of the fields produced by the E-W and N-S antennas extrapolated to full operating current (300 Amps).

TABLE H-2

SUMMARY DATA
ELECTROMAGNETIC FIELD INTENSITIES AND FLUX DENSITIES (1)
WETLANDS STUDY

(Page two of two pages)

SITE NO.	MEAS PT	ELECTRIC FIELD IN THE AIR INTENSITY (V/m)		ELECTRIC FIELD IN THE EARTH INTENSITY (V/m)		MAGNETIC FLUX DENSITY (Gauss)	
		76 Hz	60 Hz	76 Hz	60 Hz	76 Hz	60 Hz
8M2	1	0.063	<0.001	0.054	0.000064	0.00055	<0.000001
8M2	2	0.076	"	0.060	0.000071	0.00056	"
8M2	3	0.085	"	0.080	0.000094	"	"
8M3	1	0.030	"	0.023	0.000095	0.00012	"
8M3	2	0.033	"	0.032	0.00012	"	"
8M3	3	0.029	"	0.025	0.000086	0.00011	"
8M4	1	<0.001	"	0.010	0.000004	0.00016	"
8M4	2	0.006	"	0.0056	0.000001	0.00015	"
8M4	3	0.007	"	0.0041	0.000017	0.00014	"
8M5	1	<0.001	"	0.038	0.000063	0.00025	"
8M5	2	"	"	"	0.000065	0.00026	"
8M5	3	"	"	0.034	0.000054	"	"
8M6	1	"	"	0.065	0.000068	0.00088	"
8M6	2	"	"	0.070	0.000041	0.00093	"
8M6	3	"	"	0.052	0.000037	0.00088	"
8M7	1	A	A	0.040	0.000045	0.00018	"
8M7	2	"	"	0.027	0.000043	0.00019	"
8M7	3	"	"	0.029	0.000039	0.00020	"

A) Data not taken

1) Values shown are magnitudes determined as the square root of the sum of the squares of the orthogonal field components measured. Data for 76 Hz represent worst case values determined by summation of the magnitudes of the fields produced by the E-W and N-S antennas extrapolated to full operating current (300 Amps).

TABLE H-3

ELF ELECTROMAGNETIC FIELD EXPOSURE CRITERIA
FIELD INTENSITY RATIOS (1)
WETLANDS STUDY

COMPARED SITE NO.S	ELECTRIC FIELD IN THE AIR				ELECTRIC FIELD IN THE EARTH				MAGNETIC FIELD			
	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10	R1>=10.	R2>=10.	R3>=10.	0.1<R4<10
8A1/8C1	>120.	>120.	>120.	1.0	45.	3900.	1400.	0.4	920.	12000.	>24000.	2.0
8A1/8C2	"	"	"	"	71.	"	2800.	0.7	"	"	"	"
8A1/8C3	"	"	"	"	53.	"	1100.	0.3	"	"	"	"
8A2/8C1	>110.	>110.	>110.	"	51.	1900.	1600.	0.8	320.	4000.	>8000.	"
8A2/8C2	"	"	"	"	81.	"	3200.	1.7	"	"	"	"
8A2/8C3	"	"	"	"	61.	"	1200.	0.6	"	"	"	"
8A3/8C1	>130.	>130.	>130.	"	79.	2200.	2500.	1.1	880.	22000.	>22000.	1.0
8A3/8C2	"	"	"	"	120.	"	5000.	2.3	"	"	"	"
8A3/8C3	"	"	"	"	88.	"	1900.	0.9	"	"	"	"
8G1/8C1	>470.	>470.	>470.	"	240.	1200.	7500.	6.1	96.	1200.	>2400.	2.0
8G1/8C2	"	"	"	"	380.	"	15000.	12. *	"	"	"	"
8G1/8C3	"	"	"	"	260.	"	5900.	4.7	"	"	"	"
8G2/8C1	>300.	>300.	>300.	"	150.	930.	4600.	4.9	28.	>700.	>700.	1.0
8G2/8C2	"	"	"	"	230.	"	9300.	10.	"	"	"	"
8G2/8C3	"	"	"	"	160.	"	3600.	3.8	"	"	"	"

1) R1 = Test Site (76 Hz) / Control Site (76 Hz) R1 >= 10.
R2 = Test Site (76 Hz) / Test Site (60 Hz) R2 >= 10.
R3 = Test Site (76 Hz) / Control Site (60 Hz) R3 >= 10.
R4 = Test Site (60 Hz) / Control Site (60 Hz) 0.1 <= R4 <= 10.

* Does not meet the exposure criterion specification.

WETLANDS STUDY SITES

(Page one of two pages)

SITE NO	MEAS PT	ELECTRIC FIELD INTENSITY IN AIR (1) (VOLTS/METER)											
		N/S ANTENNA [Freq=76 Hz CW; I=300 A]				E/W ANTENNA [Freq=76 Hz CW; I=300 A]				AMBIENT 60 Hz			
		N-S	E-W	VERT	RSS	N-S	E-W	VERT	RSS	N-S	E-W	VERT	RSS
8A1	1	0.068	0.030	0.075	0.11	0.004	0.009	0.003	0.010	A	A	A	A
8A1	2	0.16	0.031	0.027	0.16	0.009	0.012	0.003	0.016	A	A	A	A
8A2	1	0.16	0.066	0.018	0.17	0.015	A	0.002	0.015	A	A	A	A
8A2	2	0.12	0.025	0.022	0.13	0.009	0.020	0.004	0.023	A	A	A	A
8A2	3	0.073	0.073	0.010	0.10	0.011	0.004	A	0.011	A	A	A	A
8A3	1	0.005	0.007	0.002	0.009	0.075	0.070	0.054	0.12	A	A	A	A
8A3	2	0.005	0.009	A	0.010	0.13	0.039	0.026	0.14	A	A	A	A
8A3	3	0.006	0.009	A	0.010	0.16	0.013	0.030	0.16	A	A	A	A
8G1	1	0.21	0.55	0.006	0.59	0.007	0.023	0.002	0.024	A	A	A	A
8G1	2	0.046	0.45	0.21	0.49	0.005	0.017	0.007	0.019	A	A	A	A
8G1	3	0.051	0.44	0.019	0.45	0.002	0.017	0.002	0.017	A	A	A	A
8G2	1	0.022	0.29	0.015	0.29	0.012	0.003	0.003	0.013	A	A	A	A
8G2	2	0.065	0.31	0.033	0.32	0.007	0.013	A	0.015	A	A	A	A
8G2	3	0.066	0.24	0.063	0.26	0.004	0.009	0.002	0.010	A	A	A	A
8C1	1	A	A	A	A	A	A	A	A	A	A	A	A
8C1	2	A	A	A	A	A	A	A	A	A	A	A	A
8C2	1	A	A	A	A	A	A	A	A	A	A	A	A
8C2	2	A	A	A	A	A	A	A	A	A	A	A	A
8C3	1	A	A	A	A	A	A	A	A	A	A	A	A
8C3	2	A	A	A	A	A	A	A	A	A	A	A	A
8C3	3	A	A	A	A	A	A	A	A	A	A	A	A
8M1	1	0.019	0.012	0.007	0.024	0.002	0.014	A	0.015	A	A	A	A

A), 1), 2): See footnotes, next page.

SITE NO	MEAS PT	ELECTRIC FIELD INTENSITY IN AIR (1) (VOLTS/METER)											
		N/S ANTENNA [Freq=76 Hz CW; I=300 A]				E/W ANTENNA [Freq=76 Hz CW; I=300 A]				AMBIENT 60 Hz			
		N-S	E-W	VERT	RSS	N-S	E-W	VERT	RSS	N-S	E-W	VERT	RSS
8M1	2	0.019	0.009	0.003	0.021	0.005	0.012	0.002	0.013	A	A	A	A
8M1	3	0.014	0.002	0.006	0.015	A	0.009	0.002	0.009	A	A	A	A
8M2	1	0.056	0.015	A	0.058	0.003	0.005	A	0.005	A	A	A	A
8M2	2	0.068	A	0.007	0.069	0.004	0.005	A	0.006	A	A	A	A
8M2	3	0.077	0.002	0.002	0.077	0.005	0.006	0.002	0.008	A	A	A	A
8M3	1	0.012	0.002	A	0.013	0.004	0.003	A	0.005	A	A	A	A
8M3	2	0.012	0.005	A	0.013	0.002	0.007	A	0.007	A	A	A	A
8M3	3	0.013	A	A	0.013	0.003	0.003	A	0.005	A	A	A	A
8M4	1	A	A	A	A	A	A	A	A	A	A	A	A
8M4	2	0.006	A	A	A	A	A	A	A	A	A	A	A
8M4	3	A	0.006	0.004	0.007	A	A	A	A	A	A	A	A
8M5	1	A	A	A	A	A	A	A	A	A	A	A	A
8M5	2	A	A	A	A	A	A	A	A	A	A	A	A
8M5	3	A	A	A	A	A	A	A	A	A	A	A	A
8M6	1	A	A	A	A	A	A	A	A	A	A	A	A
8M6	2	A	A	A	A	A	A	A	A	A	A	A	A
8M6	3	A	A	A	A	A	A	A	A	A	A	A	A
8M7	1	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
8M7	2	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
8M7	3	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)

A) <0.001 Volt/meter.

1) N-S, E-W, VERT are electric field intensities in the north-south, east-west, and vertical directions, respectively. Each orthogonal data component has been extrapolated to full antenna operating current, as indicated by I = 300 Amps.
The composite magnitude of the electric field intensity in air is derived from the square root of the sum of the squares and is denoted by RSS.

2) Data not taken.

SITE NO	MEAS PT	ELECTRIC FIELD INTENSITY IN EARTH (1) (VOLTS/METER)								
		N/S ANTENNA [Freq=76 Hz CW; I=300 A]			E/W ANTENNA [Freq=76 Hz CW; I=300 A]			AMBIENT 60 Hz		
		N-S	E-W	RSS	N-S	E-W	RSS	N-S	E-W	RSS
8A1	1	0.058	0.[illegible]	0.073	0.0041	0.0082	0.0092	0.000015	0.000017	0.000023
8A1	2	0.080	0	0.082	0.0031	0.0039	0.0050	0.000020	0.000004	0.000020
8A2	1	0.11	0.084	0.14	0.010	0.0030	0.011	0.000070	0.000040	0.000081
8A2	2	0.076	0.021	0.079	0.013	0.0038	0.014	0.000042	0.000012	0.000044
8A2	3	0.038	0.024	0.045	0.0041	0.00062	0.0041	0.000026	0.000013	0.000028
8A3	1	0.0046	0.0086	0.0098	0.13	0.031	0.13	0.000053	0.000038	0.000065
8A3	2	0.0046	0.0082	0.0093	0.14	0.024	0.14	0.000067	0.000024	0.000071
8A3	3	0.0048	0.0082	0.0095	0.15	0.013	0.15	0.000067	0.000019	0.000070
8G1	1	0.22	0.37	0.43	0.0040	0.015	0.016	0.000048	0.00036	0.00036
8G1	2	0.050	0.49	0.49	0.0023	0.018	0.018	0.000025	0.00041	0.00041
8G1	3	0.047	0.41	0.41	0.0026	0.015	0.015	0.000019	0.00035	0.00035
8G2	1	0.043	0.28	0.28	0.0014	0.011	0.011	0.000064	0.00029	0.00030
8G2	2	0.030	0.31	0.31	0.0013	0.012	0.012	0.000059	0.00035	0.00036
8G2	3	0.054	0.23	0.23	0.0025	0.0090	0.0093	0.000085	0.00027	0.00028
8C1	1	0.00088	0.00035	0.00095	0.00077	0.00025	0.00081	0.000036	0.000005	0.000036
8C1	2	0.00098	0.00042	0.0011	0.00088	0.00023	0.00091	0.000084	0.000016	0.000086
8C2	1	0.00045	0.00042	0.00062	0.00049	0.00033	0.00059	0.000025	0.000006	0.000026
8C2	2	0.00056	0.00033	0.00065	0.00059	0.000096	0.00060	0.000034	0.000004	0.000034
8C3	1	0.00071	0.00038	0.00081	0.00082	0.00028	0.00086	0.000074	0.000010	0.000075
8C3	2	0.00068	0.00037	0.00077	0.00082	0.00016	0.00083	0.000075	0.000016	0.000077
8C3	3	0.00080	0.00029	0.00085	0.00089	0.00018	0.00091	0.000075	0.000031	0.000081

1): See footnote, next page.

TABLE H-5

ELECTRIC FIELD INTENSITY IN EARTH
WETLANDS STUDY SITES

SITE NO	MEAS PT	ELECTRIC FIELD INTENSITY IN EARTH (1) (VOLTS/METER)								
		N/S ANTENNA [Freq=76 Hz CW; I=300 A]			E/W ANTENNA [Freq=76 Hz CW; I=300 A]			AMBIENT 60 Hz		
		N-S	E-W	RSS	N-S	E-W	RSS	N-S	E-W	RSS
8M1	1	0.017	0.0085	0.019	0.0027	0.011	0.012	0.000060	0.000068	0.000091
8M1	2	0.019	0.0076	0.021	0.0027	0.011	0.011	0.000060	0.000073	0.000094
8M1	3	0.016	0.0041	0.017	0.0042	0.0094	0.010	0.000060	0.000048	0.000077
8M2	1	0.048	0.0053	0.049	0.0024	0.0041	0.0048	0.000062	0.000014	0.000064
8M2	2	0.054	0.0092	0.055	0.0028	0.0045	0.0053	0.000070	0.000012	0.000071
8M2	3	0.074	0.0094	0.075	0.0045	0.0046	0.0064	0.000093	0.000013	0.000094
8M3	1	0.0094	0.0015	0.0095	0.0030	0.0027	0.0040	0.000088	0.000037	0.000095
8M3	2	0.013	0.0019	0.013	0.0035	0.0049	0.0060	0.00011	0.000055	0.00012
8M3	3	0.012	0.0012	0.012	0.0029	0.0021	0.0036	0.000076	0.000040	0.000086
8M4	1	0.0064	0.0018	0.0066	0.0020	0.0024	0.0031	0.000003	0.000002	0.000004
8M4	2	0.0028	0.00044	0.0028	0.0022	0.0018	0.0028	0.000001	0.000001	0.000001
8M4	3	0.0030	0.00090	0.0031	0.00062	0.00082	0.0010	0.000009	0.000015	0.000017
8M5	1	0.030	0.0040	0.030	0.0026	0.0080	0.0084	0.000060	0.000020	0.000063
8M5	2	0.028	0.010	0.030	0.0025	0.0074	0.0078	0.000060	0.000024	0.000065
8M5	3	0.025	0.0042	0.025	0.0030	0.0080	0.0085	0.000050	0.000021	0.000054
8M6	1	0.021	0.0044	0.021	0.018	0.040	0.044	0.000060	0.000032	0.000068
8M6	2	0.021	0.0018	0.021	0.028	0.040	0.049	0.000040	0.000011	0.000041
8M6	3	0.021	0.0060	0.022	0.0054	0.030	0.030	0.000030	0.000022	0.000037
8M7	1	0.019	0.010	0.021	0.0082	0.017	0.019	0.000042	0.000017	0.000045
8M7	2	0.016	0.0032	0.016	0.0068	0.0088	0.011	0.000042	0.000009	0.000043
8M7	3	0.015	0.0046	0.016	0.0072	0.011	0.013	0.000036	0.000015	0.000039

1) N-S and E-W are electric field intensities in earth in the north-south and east-west directions, respectively. Each orthogonal data component has been extrapolated to full antenna operating current, as indicated by I = 300 Amps.
The composit magnitude of the electric field intensity in earth is derived from the square root of the sum of the squares and is denoted by RSS.

TABLE H-6

MAGNETIC FLUX DENSITY
WETLANDS STUDY SITES

(Page one of two pages)

SITE NO	MEAS PT	MAGNETIC FLUX DENSITY (1) (GAUSS)											
		N/S ANTENNA [Freq=76 Hz CW; I=300 A]				E/W ANTENNA [Freq=76 Hz CW; I=300 A]				AMBIENT 60 Hz			
		N-S	E-W	VERT	RSS	N-S	E-W	VERT	RSS	N-S	E-W	VERT	RSS
8A1	1	0.0015	0.0079	0.019	0.021	0.000090	0.00026	0.00060	0.00066	A	A	A	A
8A1	2	0.0011	0.0038	0.023	0.024	0.000046	0.00012	0.00073	0.00074	A	A	0.000005	0.000005
8A2	1	0.00049	0.00025	0.0075	0.0075	0.000097	0.000029	0.00044	0.00045	A	A	0.000002	0.000002
8A2	2	0.00012	0.00026	0.0070	0.0071	0.000084	0.000011	0.00044	0.00045	A	A	A	A
8A2	3	0.00025	0.00021	0.0077	0.0077	0.000057	0.000019	0.00044	0.00045	A	A	0.000002	0.000002
8A3	1	0.000042	0.000013	0.000033	0.000055	0.00072	0.0065	0.021	0.022	A	0.000001	A	0.000001
8A3	2	0.000041	0.000014	0.000034	0.000055	0.00037	0.0040	0.021	0.021	A	0.000001	A	0.000001
8A3	3	0.000041	0.000014	0.000032	0.000054	0.00035	0.0065	0.022	0.023	A	0.000001	A	0.000001
8G1	1	0.00023	0.000053	0.0023	0.0023	0.000030	0.000016	0.000075	0.000083	A	A	0.000002	0.000002
8G1	2	0.00018	0.00034	0.0023	0.0023	0.000030	0.000012	0.000077	0.000083	A	A	0.000002	0.000002
8G1	3	0.00041	0.00025	0.0022	0.0022	0.000030	0.000022	0.000071	0.000081	A	A	0.000002	0.000002
8G2	1	0.00023	0.000054	0.00058	0.00063	0.000030	0.000008	0.000022	0.000038	A	A	0.000001	0.000001
8G2	2	0.00030	0.000026	0.00061	0.00068	0.000048	0.000015	0.000021	0.000054	A	A	0.000001	0.000001
8G2	3	0.00018	0.00020	0.00061	0.00066	0.000030	0.000008	0.000024	0.000039	A	A	0.000001	0.000001
8C1	1	0.000010	0.000006	0.000007	0.000014	0.000007	0.000007	0.000005	0.000011	A	A	A	A
8C1	2	0.000010	0.000007	0.000007	0.000014	0.000007	0.000007	A	0.000010	A	A	A	A
8C2	1	0.000008	0.000009	0.000004	0.000013	0.000006	0.000009	0.000003	0.000011	A	A	A	A
8C2	2	0.000007	0.000009	0.000004	0.000012	0.000005	0.000009	0.000004	0.000011	A	A	A	A
8C3	1	0.000008	0.000009	0.000004	0.000013	0.000007	0.000009	0.000005	0.000012	A	A	A	A
8C3	2	0.000008	0.000009	0.000004	0.000013	0.000007	0.000009	0.000005	0.000012	A	A	A	A
8C3	3	0.000008	0.000009	0.000004	0.000013	0.000007	0.000009	0.000005	0.000012	A	A	A	A

A), 1): See footnotes, next page.

TABLE H-6

MAGNETIC FLUX DENSITY
WETLANDS STUDY SITES

SITE NO	MEAS PT	MAGNETIC FLUX DENSITY (1) (GAUSS)											
		N/S ANTENNA [Freq=76 Hz CW; I=300 A]				E/W ANTENNA [Freq=76 Hz CW; I=300 A]				AMBIENT 60 Hz			
		N-S	E-W	VERT	RSS	N-S	E-W	VERT	RSS	N-S	E-W	VERT	RSS
8M1	1	0.000027	0.000090	0.00012	0.00015	0.000057	0.000011	0.000038	0.000070	A	A	A	A
8M1	2	0.000022	0.000090	0.00012	0.00015	0.000057	0.000010	0.000040	0.000070	A	A	A	A
8M1	3	0.000011	0.000084	0.00012	0.00015	0.000055	0.000011	0.000041	0.000069	A	A	A	A
8M2	1	0.000014	0.00017	0.00045	0.00048	0.000046	0.000010	0.000057	0.000074	A	A	A	A
8M2	2	0.000036	0.00014	0.00046	0.00049	0.000055	0.000008	0.000053	0.000077	A	A	A	A
8M2	3	0.000033	0.00014	0.00045	0.00048	0.000054	0.000016	0.000051	0.000076	A	A	A	A
8M3	1	0.000057	0.000023	0.000051	0.000080	0.000031	0.000010	0.000016	0.000036	A	A	A	A
8M3	2	0.000058	0.000026	0.000048	0.000080	0.000030	0.000015	0.000015	0.000037	A	A	A	A
8M3	3	0.000047	0.000035	0.000051	0.000078	0.000029	0.000003	0.000017	0.000034	A	A	A	A
8M4	1	0.000044	0.000073	0.000054	0.00010	0.000042	0.000031	0.000025	0.000058	A	A	A	A
8M4	2	0.000027	0.000080	0.000054	0.00010	0.000031	0.000027	0.000023	0.000047	A	A	A	A
8M4	3	0.000035	0.000067	0.000045	0.000088	0.000037	0.000024	0.000022	0.000049	A	A	A	A
8M5	1	0.000054	0.000069	0.00015	0.00017	0.000050	0.000018	0.000057	0.000078	A	A	A	A
8M5	2	0.000046	0.000084	0.00015	0.00018	0.000054	0.000004	0.000061	0.000082	A	A	A	A
8M5	3	0.000009	0.000092	0.00015	0.00018	0.000050	0.000008	0.000061	0.000079	A	A	A	A
8M6	1	0.000034	0.00010	0.00015	0.00018	0.00012	0.000057	0.00069	0.00070	A	A	A	A
8M6	2	0.000042	0.000092	0.00015	0.00018	0.00012	0.000092	0.00073	0.00075	A	A	A	A
8M6	3	0.000011	0.00010	0.00015	0.00018	0.00012	0.000080	0.00069	0.00070	A	A	A	A
8M7	1	0.000020	0.000051	0.000046	0.000072	0.000074	0.000014	0.000083	0.00011	A	A	A	A
8M7	2	0.000018	0.000053	0.000046	0.000072	0.000074	0.000019	0.000090	0.00012	A	A	A	A
8M7	3	0.000022	0.000055	0.000048	0.000076	0.000078	0.000014	0.000088	0.00012	A	A	A	A

A) <0.000001 Gauss

1) N-S, E-W, VERT are magnetic flux densities in the north-south, east-west, and vertical directions, respectively. Each orthogonal data component has been extrapolated to full antenna operating current, as indicated by I = 300 Amps.
The composite magnitude of the magnetic flux density is derived from the square root of the sum of the squares and is denoted by RSS.

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